

Hydrology Summary

17

Flow data for the Androscoggin River was provided by MDOT in a memo dated March 10, 2014. USGS data was provided by USGS in reports on the 1936 and 1987 floods. The 1936 flood was estimated to be an approximate 500-year event and the 1987 flood was estimated to be an approximate 200-year event. The 1936 and 1987 floods were added to the MDOT table using the Area-Discharge equation developed by MDOT. MDOT calculations are included in Appendix D.

Design Hydrology Summary		
Drainage Area	2,332	mi ²
Ordinary High Water (Q _{1.1})	18,963	ft ³ / s
(Q ₁₀)	47,180	ft ³ / s
(Q ₂₅)	55,409	ft ³ / s
Design Discharge (Q ₅₀)	61,408	ft ³ / s
Check Discharge (Q ₁₀₀)	67,324	ft ³ / s
Recent Flood (1987) (Q ₂₀₀)	69,885	ft ³ / s
Flood of Record (1936) (Q ₅₀₀)	80,745	ft ³ / s
Scour Check Discharge (Q ₅₀₀)	80,942	ft ³ / s

Reported By: Charles Hebson (MDOT)
Ronald L. Joy, PE (MJ)

Date(s): March 10, 2014
 October 23, 2014

The 2009 Oxford County Flood Insurance Study (FIS) merged the 1990 Peru and the 1981 Mexico FIS peak discharge values at common locations as depicted below.

2009 Oxford County Flood Insurance Study (FIS) Peak Discharge Summary

Location	10-Year	50-Year	100-Year	500-Year
Rumford-Peru Town Line	51,000	68,600	78,000	98,600
Upstream of confluence with Webb River	--	--	78,000	--
Upstream of confluence with Spears Stream	--	--	81,500	--

The North Main Street bridge crosses the Androscoggin River immediately upstream of the confluence with the Webb River, and the FIS reported the peak discharge of 78,000 cfs for the 100-year event, this is well above the 67,324 cfs estimated by MDOT. Since the FIS only evaluated a single storm event, with a magnitude found to be 15% greater than recently estimated value, starting water surface elevations (SWSEL) could not be obtained from the FEMA FIS.

Historical flood records for the 1987 and 1936 floods published by the USGS are shown below.

Historical Flood Data

Flood	Location (Miles Upstream from Mouth)	Description	Elevation	
			NGVD 1929	NAVD 1988
1987 (Q ₂₀₀)	82.0 miles	Dixfield, Maine, downstream side highway bridge, left bank	415.1	414.6
1936 (Q ₅₀₀)	82.0 miles	Dixfield, Maine, Maine Central RR Co. Station, Copper Plate, left bank	417.5	417.0

All elevations are based on North American Vertical Datum (NAVD) of 1988. Elevations based on the National Geodetic Vertical Datum (NGVD) of 1929 were converted to NAVD by subtracting 0.47 feet.

An existing condition model, that incorporated the 1987 and 1936 floods, was developed to estimate SWSEL's by incorporating the boundary condition of normal depth with estimated downstream channel slope. A downstream energy grade (EG) was set at 0.000148 for each storm and the resulting WSEL's at the downstream channel section was generally within 0.5 feet of the USGS published values. The EG was incorporated for all storm events and resulting SWSEL's were obtained for the analysis models.

Specific river sections were surveyed and provided by the Maine DOT Survey Section. Geometric data for the existing bridge was taken from the existing bridge plans. (See Appendix F). All elevations were referenced to the project datum (NAVD 1988). Geometric data for the proposed bridge was taken from the preliminary design and plans (see Appendix A).

Manning's "n" values were based on information from the FEMA study, with channel "n" consisting of 0.03-0.04 and overbank "n" consisting of 0.06-0.07.

Hydraulic Summary				
	Existing Structure		Recommended Structure	
	3-Span Parker Thru Truss (574 Feet)		Alternative C2 4-Span Plate Girder (600 Feet)	
Q _{1.1} Headwater Elevation	403.91	ft	403.89	ft
Q ₅₀ Headwater Elevation	413.59	ft	413.59	ft
Q ₁₀₀ Headwater Elevation	414.46	ft	414.48	ft
Q _{1.1} Discharge Velocity	3.4	ft / s	3.3	ft / s
Q ₅₀ Discharge Velocity	5.9	ft / s	5.4	ft / s
Q ₁₀₀ Discharge Velocity	6.3	ft / s	5.7	ft / s
Bottom Beam Elevation	410.23	ft	414.57	ft
Q ₅₀ Discharge Velocity	-3.36	ft	2.01	ft
Q ₁₀₀ Discharge Velocity	-4.23	ft	1.12	ft

Though borings and grain size analysis to estimate D₅₀ of bed material at the proposed piers have not been obtained within the channel at this time, a preliminary scour analysis was performed. Potential scour was computed for the proposed abutments and piers. Computations were done according to FHWA guidelines as published in HEC-18 and associated guidance documents, HEC-23 and HEC-20. Stream bottom material is described in the 1930 project plans as gravel.

The proposed bridge shows some contraction scour, pier scour at all piers and abutment scour as follows. These preliminary scour estimates are computed by HEC-RAS and will be refined as the bridge design is refined. These calculations assume no scour protection. Scour countermeasures will be designed once current soil parameters are obtained and design advanced at the proposed substructure elements.

Reported By: Ronald L. Joy, PE (MJ)
Date: October 23, 2014

APPENDIX D

Hydrology & Hydraulic Documentation

Hydrology, Hydraulics & Scour Data:

1. Hydrology
 - a. Final design flows derived from Rumford gage (01040002) provided by the Maine DOT. Environmental Office – Hydrology Section.
 - b. Flows as reported in the 2009 Oxford County Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS).
 - c. Flows as reported in the 1990 Town of Peru Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS).
 - d. Flows as reported in the 1981 Town of Mexico Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS).
2. Hydraulics
 - a. Androscoggin River Site Map
 - b. FEMA Composite FIRM
 - c. USGS 1936 Storm Elevations
 - d. USGS 1987 Storm Elevations
 - e. 1932 Photograph of Dixfield Railroad Station (obtained from UConn Library)
 - f. Oxford County FIS Flood Profile
 - g. Oxford County FIS Floodway Data
 - h. HEC-RAS “Existing” Plan Cross Sections
 - i. HEC-RAS “Alternative C” Plan Cross Sections
 - j. HEC-RAS Composite Hydraulic Results Table
3. Scour
 - a. HEC-RAS Bridge Cross Section
 - b. HEC-RAS Scour Results

Environmental Office – Hydrology Section
 16 State House Station
 Augusta ME 04333-0016
 207.557.1052
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Maine Department of Transportation

Memo

To: Janet Damren
From: Charles Hebson
CC:
Date: 10 March 2014
Re: 18498 Peru-Mexico Androscoggin River Bridge #2019

The final recommended design hydrology is summarized in Table 1 and Figure 1 below.

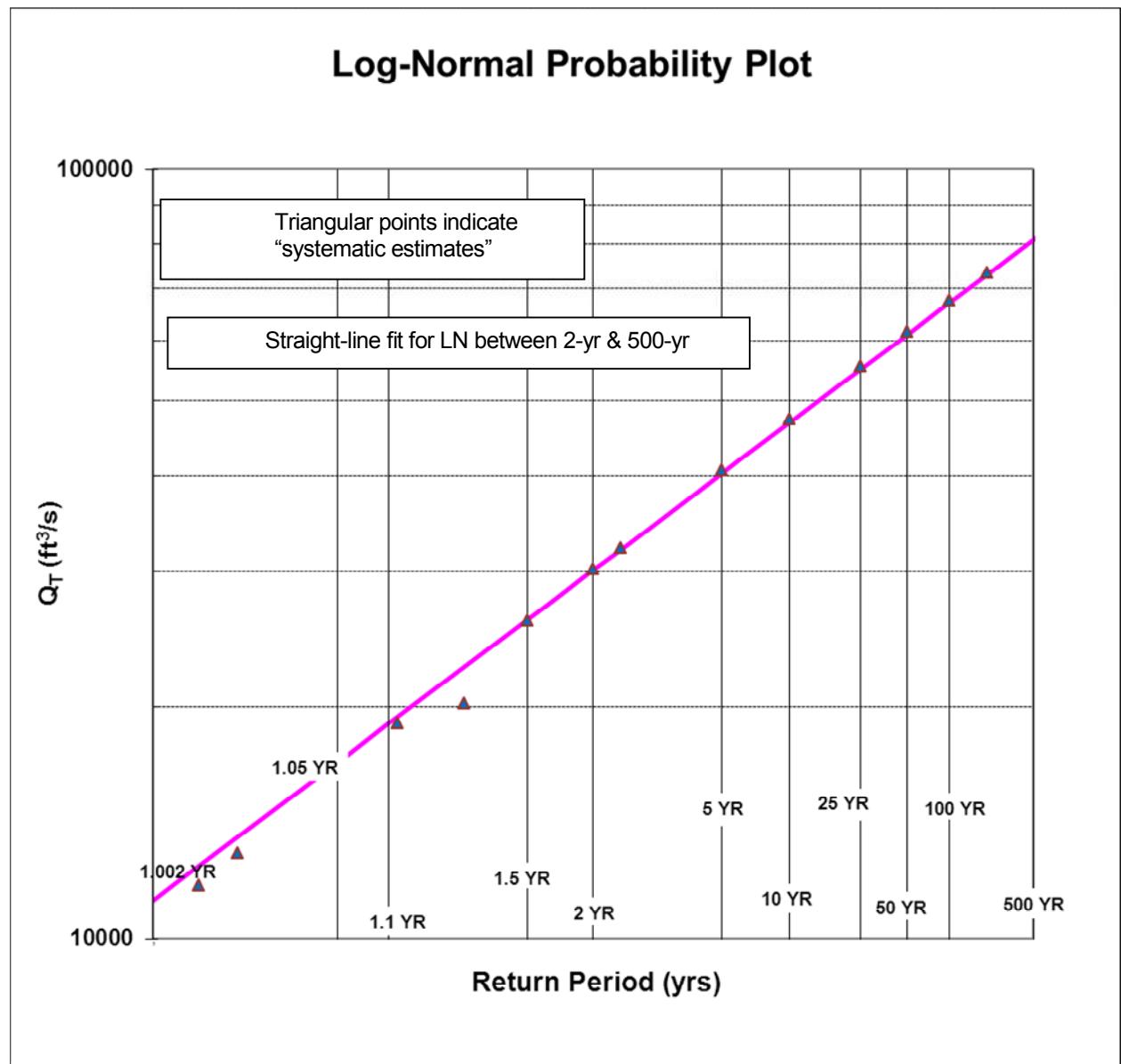
Table 1. Design Hydrology Summary

Area (mi ²)			2332	2069	
NWI (%) (actual)			--	--	
NWI (%) (fit)			--		
Return Period T	Exceedance Prob P _{ex}	Area exponent "a"	<i>Final Recommended Q_T (ft³/s)</i>	USGS gage (19-2012) Bull. 17B Est.	USGS gage (19-2012) Systematic Record
1.005	0.995	0.855	11 687	10 680	10 550
1.01	0.990	0.855	12 850	11 700	11 600
1.05	0.952	0.852	16 588	15 030	14 980
1.1	0.909	0.850	18 963	17 150	17 130
1.5	0.667	0.836	25 839	23 340	23 380
2	0.500	0.825	30 144	27 260	27 310
5	0.200	0.797	40 515	36 810	36 830
10	0.100	0.783	47 180	43 020	42 960
25	0.040	0.767	55 409	50 760	50 550
50	0.020	0.757	61 408	56 460	56 090
100	0.010	0.748	67 324	62 120	61 560
500	0.002	0.729	80 942	75 280	74 180

Notes: Q_T at project = (A_{ws}/A_{gage})^a × Q_{T-gage}, using “systematic record” results at gage

USGS Gage #01040002, “Androscoggin River at Rumford, Maine”

Figure 1. Probability Plot – Androscoggin River at Peru-Mexico Bridge, #2019



Discussion

MaineDOT design hydrology for larger structures is ordinarily calculated with statewide peak flow regression equations (Hodgkins, 1999). However, this is not recommended for the Peru-Mexico Bridge location because the Androscoggin River above the Peru-Mexico Bridge is regulated by numerous dams; the statewide equations are intended for undeveloped, unregulated watersheds.

Fortunately, there is a USGS gage (01040002, "Androscoggin River at Rumford, Maine", just upstream downstream of the bridge. The watershed area at the gage A_g (2069 mi^2) is just slightly less than the area at the bridge (2332 mi^2), so adjustment by area scaling is straightforward. The watershed delineation is shown in Figure 2; the gage annual maximum flows are shown in Figure 3.

The standard site regression equations Q_r are of the form

$$Q_r = cA^a 10^{wW}$$

where the parameters c , a , and w vary according to return period (Hodgkins, Table 3); A is watershed area and W is the percentage of watershed area that is mapped as NWI wetlands. A simplified area-only equation is

$$Q_r = cA^a$$

where "a" takes on slightly different values than in the complete equation. The watershed area A at the bridge was determined in ArcGIS from available watershed delineations. The bridge connects the towns of Peru and Mexico.

Using the simplified regression equation, a site estimate is calculated from the gage estimates Q_g by area scaling:

$$Q_u = (A_u/A_g)^a Q_g$$

where "a" is the area exponent in the simplified area-only equations; "u" corresponds to the ungaged project site and "g" corresponds to the gaged watershed. Values of "a" are listed in Table 1 above; they are also shown graphically in Figure 4. Hodgkins does not give "a" values for all return period (T) values, so the missing values have been interpolated/extrapolated as needed.

The peak flow estimates Q_g at the Rumford gage (01040002) were calculated from the gage data using the USGS program PeakFQ (Flynn et al, 2006). Program output is reproduced in Appendix A. This program produces estimates according to the standard "Bulletin 17b" procedures, fitting the annual maximum data to the Log-Pearson III (LP-III) probability distribution. A generalized statewide skew value of 0.029 was used (Hodgkins, 1999). This skew value is so small that the LP-III distribution is closely approximated by the simpler log-Normal (LN) distribution, as evidenced by a straight-line plot on LN-probability scale. PeakFQ also produces estimates using plotting positions applied to the systematic record. These "systematic record" estimates were ultimately chosen as the basis for project design hydrology because the record length is so long.

References:

Hodgkins, 1999. Estimating the Magnitude of Peak Flows for Stream in Maine for Selected Recurrence Intervals, US Geological Survey, *WRIR 99-4408*.

Flynn, K., W.H. Kirby, & P.R. Hummel, 2006. User's Manual for Program PeakFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines. US Geological Survey, *Techniques & Methods 4-B4*.

Figure 2. Androscoggin River (Peru-Mexico) Bridge Watershed



Figure 3. Androscoggin River at Rumford – Annual Maxima

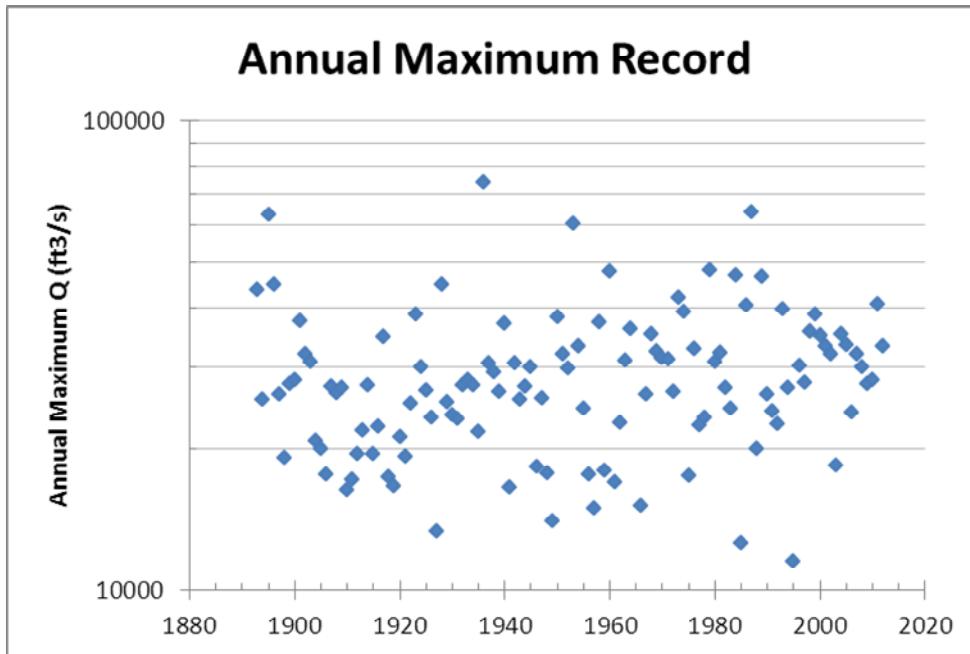
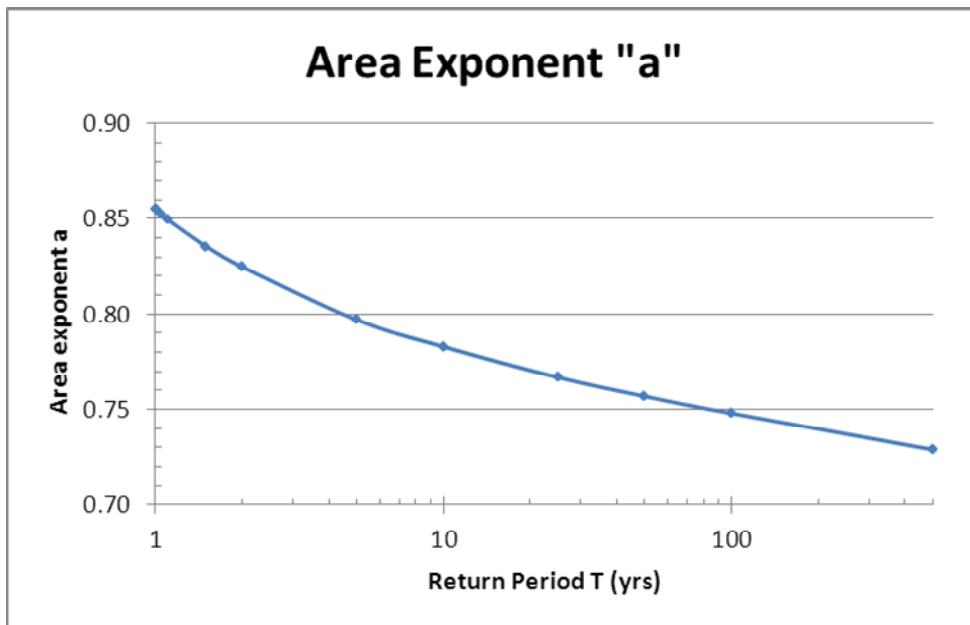


Figure 4. Area Exponent "a" for Watershed Scaling of Peak Flow Estimates



Appendix:

**Output for Androscoggin River - Rumford Gage from
USGS Program PeakFQ**

Program PeakFq
Ver. 5.2
11/01/2007

U. S. GEOLOGICAL SURVEY
Annual peak flow frequency analysis
following Bulletin 17-B Guidelines

Seq.000.000
Run Date / Time
03/10/2014 13:42

--- PROCESSING OPTIONS ---

Plot option = Graphics device
Basin char output = None
Print option = Yes
Debug print = Yes
Input peaks listing = Long
Input peaks format = WATSTORE peak file

Input files used:

RUM.TXT

peaks (ascii) - D:\PROGFILS\PEAKFQ\TEST\DATA_IN\ANDRO-

specifications - PKFQWPSF.TMP

Output file(s):

main - D:\PROGFILS\PEAKFQ\TEST\DATA_IN\ANDRO-RUM.PRT

Station - 01054500 Androscoggin River at Rumford, Maine

I N P U T D A T A S U M M A R Y

Number of peaks in record	=	120
Peaks not used in analysis	=	0
Systematic peaks in analysis	=	120
Historic peaks in analysis	=	0
Years of historic record	=	0
Generalized skew	=	0.029
Standard error	=	0.297
Mean Square error	=	0.088
Skew option	=	WEIGHTED
Gage base discharge	=	0.0
User supplied high outlier threshold	=	--
User supplied low outlier criterion	=	--
Plotting position parameter	=	0.00

***** NOTICE -- Preliminary machine computations. *****
***** User responsible for assessment and interpretation. *****

PeakFQ-DEBUG OPTION SET = 1
 WCF001J-FLOOD FREQUENCY, BULLETIN 17-B. VER 2.6P (12/19/83)
 -PRELIMINARY MACHINE COMPUTATIONS. USER IS RE-
 -SPONSIBLE FOR ASSESSMENT AND INTERPRETATION.
 WCF101L-INPUT PARAMS- GENSku OPT STD-ERR GAGEB QLWOUT QHIOUT NHIST HISTPD
 0.029 0 0.297 0.0 0.0 0.0 0 0 0.0
 WCF103L-INPUT PEAKS,HISTORIC FIRST. TOTAL NO = 120
 43700.0 25500.0 63300.0 44700.0 26300.0
 19200.0 27600.0 28100.0 37500.0 31900.0
 30700.0 20900.0 20100.0 17700.0 27300.0
 26400.0 27100.0 16400.0 17200.0 19500.0
 21900.0 27400.0 19600.0 22400.0 34800.0
 17400.0 16700.0 21300.0 19300.0 25100.0
 38800.0 30000.0 26800.0 23400.0 13300.0
 44800.0 25200.0 23600.0 23200.0 27500.0
 28100.0 27400.0 21800.0 74000.0 30600.0
 29200.0 26500.0 36900.0 16600.0 30500.0
 25600.0 27200.0 29900.0 18400.0 25700.0
 17800.0 14000.0 38300.0 31900.0 29800.0
 60600.0 33100.0 24500.0 17700.0 15000.0
 37300.0 18000.0 47800.0 17000.0 22800.0
 30900.0 36100.0 9320.0 15100.0 26300.0
 35200.0 32300.0 31300.0 31100.0 26600.0
 42000.0 39200.0 17500.0 32700.0 22500.0
 23400.0 48200.0 30800.0 32100.0 27100.0
 24400.0 47000.0 12600.0 40400.0 63900.0
 20100.0 46700.0 26200.0 24200.0 22700.0
 39800.0 27000.0 11500.0 30100.0 27800.0
 35600.0 38800.0 34900.0 33100.0 31900.0
 18500.0 35200.0 33500.0 24000.0 31900.0
 30000.0 27600.0 28100.0 40700.0 33100.0
 WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE. 0.0
 WCF203J-PLOTTING POSITIONS OF TOP TEN PEAKS. SYS
 0.0083 0.0165 0.0248 0.0331 0.0413 0.0496 0.0579 0.0661 0.0744 0.0826
 WCF217L-FREQUENCY CURVE PARAMS -- SYS 1.0000 4.4346 0.1558 -0.0672
 4.4346 0.1558 -0.0672
 WCF219J-FREQ CURVE ORDINATES SYS 2-YR (.50) 10-YR (.10) 100-YR (.01)
 27310.9 42963.5 61562.0
 WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION. 9016.6
 WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE. 82061.3
 WCF203J-PLOTTING POSITIONS OF TOP TEN PEAKS. 17B
 0.0083 0.0165 0.0248 0.0331 0.0413 0.0496 0.0579 0.0661 0.0744 0.0826
 WCF217L-FREQUENCY CURVE PARAMS -- 17B 1.0000 4.4346 0.1558 -0.0334
 4.4346 0.1558 -0.0672
 WCF219J-FREQ CURVE ORDINATES 17B 2-YR (.50) 10-YR (.10) 100-YR (.01)
 27256.2 43022.4 62117.1
 WCF238J-FREQ CURVE 17B-EXPECT-PROB. 27256.2 43216.0 63035.5
 WCF239J-FREQ CURVE CONF LIMS B17B 95.0 28774.5 46542.1 69601.2
 25819.1 40190.6 56501.1
 WCF002J-CALCS COMPLETED. RETURN CODE = 0

Program PeakFq
Ver. 5.2
11/01/2007

U. S. GEOLOGICAL SURVEY
Annual peak flow frequency analysis
following Bulletin 17-B Guidelines

Seq.001.002
Run Date / Time
03/10/2014 13:42

Station - 01054500 Androscoggin River at Rumford, Maine

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	EXCEEDANCE DISCHARGE	PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC PKS					
ABOVE BASE	---	---	4.4346	0.1558	-0.067
BULL.17B-ADJ PKS					
ABOVE BASE	---	---	4.4346	0.1558	-0.067
SYSTEMATIC RECORD	0.0	1.0000	4.4346	0.1558	-0.067
BULL.17B ESTIMATE	0.0	1.0000	4.4346	0.1558	-0.033

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY'	95-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES	
			ESTIMATE	LOWER	UPPER
0.9950	10680.0	10550.0	10470.0	9419.0	11840.0
0.9900	11700.0	11600.0	11520.0	10430.0	12890.0
0.9500	15030.0	14980.0	14920.0	13720.0	16230.0
0.9000	17150.0	17130.0	17080.0	15850.0	18370.0
0.8000	20120.0	20140.0	20080.0	18830.0	21360.0
0.6667	23340.0	23380.0	23320.0	22020.0	24660.0
0.5000	27260.0	27310.0	27260.0	25820.0	28770.0
0.4292	29060.0	29110.0	29060.0	27530.0	30710.0
0.2000	36810.0	36830.0	36890.0	34670.0	39350.0
0.1000	43020.0	42960.0	43220.0	40190.0	46540.0
0.0400	50760.0	50550.0	51170.0	46900.0	55740.0
0.0200	56460.0	56090.0	57100.0	51750.0	62650.0
0.0100	62120.0	61560.0	63040.0	56500.0	69600.0
0.0050	67770.0	67000.0	69040.0	61200.0	76630.0
0.0020	75280.0	74180.0	77130.0	67390.0	86090.0

Program PeakFq
Ver. 5.2
11/01/2007

U. S. GEOLOGICAL SURVEY
Annual peak flow frequency analysis
following Bulletin 17-B Guidelines

Seq.001.003
Run Date / Time
03/10/2014 13:42

Station - 01054500 Androscoggin River at Rumford, Maine

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1893	43700.0	K	1953	60600.0	K
1894	25500.0	K	1954	33100.0	K
1895	63300.0	K	1955	24500.0	K
1896	44700.0	K	1956	17700.0	K
1897	26300.0	K	1957	15000.0	K
1898	19200.0	K	1958	37300.0	K
1899	27600.0	K	1959	18000.0	K
1900	28100.0	K	1960	47800.0	K
1901	37500.0	K	1961	17000.0	K
1902	31900.0	K	1962	22800.0	K
1903	30700.0	K	1963	30900.0	K
1904	20900.0	K	1964	36100.0	K
1905	20100.0	K	1965	9320.0	K
1906	17700.0	K	1966	15100.0	K
1907	27300.0	K	1967	26300.0	K
1908	26400.0	K	1968	35200.0	K
1909	27100.0	K	1969	32300.0	K
1910	16400.0	K	1970	31300.0	K
1911	17200.0	K	1971	31100.0	K
1912	19500.0	K	1972	26600.0	K
1913	21900.0	K	1973	42000.0	K
1914	27400.0	K	1974	39200.0	K
1915	19600.0	K	1975	17500.0	K
1916	22400.0	K	1976	32700.0	K
1917	34800.0	K	1977	22500.0	K
1918	17400.0	K	1978	23400.0	K
1919	16700.0	K	1979	48200.0	K
1920	21300.0	K	1980	30800.0	K
1921	19300.0	K	1981	32100.0	K
1922	25100.0	K	1982	27100.0	K
1923	38800.0	K	1983	24400.0	K
1924	30000.0	K	1984	47000.0	K
1925	26800.0	K	1985	12600.0	K
1926	23400.0	K	1986	40400.0	K
1927	13300.0	K	1987	63900.0	K
1928	44800.0	K	1988	20100.0	K
1929	25200.0	K	1989	46700.0	K
1930	23600.0	K	1990	26200.0	K
1931	23200.0	K	1991	24200.0	K
1932	27500.0	K	1992	22700.0	K
1933	28100.0	K	1993	39800.0	K
1934	27400.0	K	1994	27000.0	K
1935	21800.0	K	1995	11500.0	K

1936	74000.0	K	1996	30100.0	K
1937	30600.0	K	1997	27800.0	K
1938	29200.0	K	1998	35600.0	K
1939	26500.0	K	1999	38800.0	K
1940	36900.0	K	2000	34900.0	K
1941	16600.0	K	2001	33100.0	K
1942	30500.0	K	2002	31900.0	K
1943	25600.0	K	2003	18500.0	K
1944	27200.0	K	2004	35200.0	K
1945	29900.0	K	2005	33500.0	K
1946	18400.0	K	2006	24000.0	K
1947	25700.0	K	2007	31900.0	K
1948	17800.0	K	2008	30000.0	K
1949	14000.0	K	2009	27600.0	K
1950	38300.0	K	2010	28100.0	K
1951	31900.0	K	2011	40700.0	K
1952	29800.0	K	2012	33100.0	K

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
-8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

Program PeakFq
Ver. 5.2
11/01/2007

U. S. GEOLOGICAL SURVEY
Annual peak flow frequency analysis
following Bulletin 17-B Guidelines

Seq.001.004
Run Date / Time
03/10/2014 13:42

Station - 01054500 Androscoggin River at Rumford, Maine

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1936	74000.0	0.0083	0.0083
1987	63900.0	0.0165	0.0165
1895	63300.0	0.0248	0.0248
1953	60600.0	0.0331	0.0331
1979	48200.0	0.0413	0.0413
1960	47800.0	0.0496	0.0496
1984	47000.0	0.0579	0.0579
1989	46700.0	0.0661	0.0661
1928	44800.0	0.0744	0.0744
1896	44700.0	0.0826	0.0826
1893	43700.0	0.0909	0.0909
1973	42000.0	0.0992	0.0992
2011	40700.0	0.1074	0.1074
1986	40400.0	0.1157	0.1157
1993	39800.0	0.1240	0.1240
1974	39200.0	0.1322	0.1322
1923	38800.0	0.1405	0.1405
1999	38800.0	0.1488	0.1488
1950	38300.0	0.1570	0.1570
1901	37500.0	0.1653	0.1653
1958	37300.0	0.1736	0.1736
1940	36900.0	0.1818	0.1818
1964	36100.0	0.1901	0.1901
1998	35600.0	0.1983	0.1983
1968	35200.0	0.2066	0.2066
2004	35200.0	0.2149	0.2149
2000	34900.0	0.2231	0.2231
1917	34800.0	0.2314	0.2314
2005	33500.0	0.2397	0.2397
1954	33100.0	0.2479	0.2479
2001	33100.0	0.2562	0.2562
2012	33100.0	0.2645	0.2645
1976	32700.0	0.2727	0.2727
1969	32300.0	0.2810	0.2810
1981	32100.0	0.2893	0.2893
1902	31900.0	0.2975	0.2975
1951	31900.0	0.3058	0.3058
2002	31900.0	0.3140	0.3140
2007	31900.0	0.3223	0.3223
1970	31300.0	0.3306	0.3306
1971	31100.0	0.3388	0.3388
1963	30900.0	0.3471	0.3471
1980	30800.0	0.3554	0.3554

1903	30700.0	0.3636	0.3636
1937	30600.0	0.3719	0.3719
1942	30500.0	0.3802	0.3802
1996	30100.0	0.3884	0.3884
1924	30000.0	0.3967	0.3967
2008	30000.0	0.4050	0.4050
1945	29900.0	0.4132	0.4132
1952	29800.0	0.4215	0.4215
1938	29200.0	0.4298	0.4298
1900	28100.0	0.4380	0.4380
1933	28100.0	0.4463	0.4463
2010	28100.0	0.4545	0.4545
1997	27800.0	0.4628	0.4628
1899	27600.0	0.4711	0.4711
2009	27600.0	0.4793	0.4793
1932	27500.0	0.4876	0.4876
1914	27400.0	0.4959	0.4959
1934	27400.0	0.5041	0.5041
1907	27300.0	0.5124	0.5124
1944	27200.0	0.5207	0.5207
1909	27100.0	0.5289	0.5289
1982	27100.0	0.5372	0.5372
1994	27000.0	0.5455	0.5455
1925	26800.0	0.5537	0.5537
1972	26600.0	0.5620	0.5620
1939	26500.0	0.5702	0.5702
1908	26400.0	0.5785	0.5785
1897	26300.0	0.5868	0.5868
1967	26300.0	0.5950	0.5950
1990	26200.0	0.6033	0.6033
1947	25700.0	0.6116	0.6116
1943	25600.0	0.6198	0.6198
1894	25500.0	0.6281	0.6281
1929	25200.0	0.6364	0.6364
1922	25100.0	0.6446	0.6446
1955	24500.0	0.6529	0.6529
1983	24400.0	0.6612	0.6612
1991	24200.0	0.6694	0.6694
2006	24000.0	0.6777	0.6777
1930	23600.0	0.6860	0.6860
1926	23400.0	0.6942	0.6942
1978	23400.0	0.7025	0.7025
1931	23200.0	0.7107	0.7107
1962	22800.0	0.7190	0.7190
1992	22700.0	0.7273	0.7273
1977	22500.0	0.7355	0.7355
1916	22400.0	0.7438	0.7438
1913	21900.0	0.7521	0.7521
1935	21800.0	0.7603	0.7603
1920	21300.0	0.7686	0.7686
1904	20900.0	0.7769	0.7769
1905	20100.0	0.7851	0.7851
1988	20100.0	0.7934	0.7934
1915	19600.0	0.8017	0.8017
1912	19500.0	0.8099	0.8099
1921	19300.0	0.8182	0.8182

1898	19200.0	0.8264	0.8264
2003	18500.0	0.8347	0.8347
1946	18400.0	0.8430	0.8430
1959	18000.0	0.8512	0.8512
1948	17800.0	0.8595	0.8595
1906	17700.0	0.8678	0.8678
1956	17700.0	0.8760	0.8760
1975	17500.0	0.8843	0.8843
1918	17400.0	0.8926	0.8926
1911	17200.0	0.9008	0.9008
1961	17000.0	0.9091	0.9091
1919	16700.0	0.9174	0.9174
1941	16600.0	0.9256	0.9256
1910	16400.0	0.9339	0.9339
1966	15100.0	0.9421	0.9421
1957	15000.0	0.9504	0.9504
1949	14000.0	0.9587	0.9587
1927	13300.0	0.9669	0.9669
1985	12600.0	0.9752	0.9752
1995	11500.0	0.9835	0.9835
1965	9320.0	0.9917	0.9917

```
End PeakFQ analysis.  
Stations processed : 1  
Number of errors   : 0  
Stations skipped   : 0  
Station years      : 120
```

Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4, or *.)
(2, 4, and * records are ignored.)

For the station below, the following records were ignored:
01054500 USGS

FINISHED PROCESSING STATION: 01054500 Androscoggin River at Rumford

For the station below, the following records were ignored:

FINISHED PROCESSING STATION:

TABLE 7 – SUMMARY OF DISCHARGES

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (SQUARE MILES)</u>	<u>PEAK DISCHARGES (CUBIC FEET PER SECOND)</u>			
		<u>10-PERCENT ANNUAL CHANCE</u>	<u>2-PERCENT ANNUAL CHANCE</u>	<u>1-PERCENT ANNUAL CHANCE</u>	<u>0.2-PERCENT ANNUAL CHANCE</u>
Alder River					
At State Route 26	29.0	2,100	3,900	4,900	7,200
At Rabbit Road	11.9	500	900	1,200	1,600
Androscoggin River					
At downstream Bethel corporate limit	1,834.0	32,700	45,000	50,500	64,500
At downstream Canton corporate limits	2,470.0	52,600	73,800	85,200	113,000
At U.S. Route 2 (State Routes 5 & 26)	1,680.0	28,100	38,000	42,400	53,400
At upstream Bethel corporate limits	1,629.0	26,500	35,600	39,600	49,500
At Riley Dam	2,466.0	*	*	85,200	*
<u>Upstream of the confluence of Spears Stream</u>	<u>2,336.0</u>	<u>*</u>	<u>*</u>	<u>81,500</u>	<u>*</u>
<u>At Rumford-Peru town line</u>	<u>2,210.0</u>	<u>51,000</u>	<u>68,600</u>	<u>78,000</u>	<u>98,600</u>
Above confluence with Swift River	2,070.0	40,300	55,400	62,500	80,000
<u>Upstream of confluence of Webb River</u>	<u>2,204.0</u>	<u>*</u>	<u>*</u>	<u>78,000</u>	<u>*</u>
Above confluence with Ellis River	1,870.0	34,300	47,700	53,900	69,400
Aunt Hannah Brook					
At Weld Road	5.2	505	970	1,175	1,695
Barkers Brook					
At confluence with Sunday River	3.4	*	*	1,035	*
Approximately 5280 feet upstream from confluence with Sunday River	2.6	*	*	831	*
Above confluence of South Barkers Brook	0.6	*	*	271	*

*Data not computed

Flood flows computed for the Rumford and Lewiston Flood Insurance Studies were updated using data at USGS stations No. 01054500 and No. 01059000 for the period up to and including the April 1987 flood (Reference 7). The revised flood flows fell within the 90-percent confidence interval of discharges determined for the Lewiston and Rumford studies; therefore, the results of those studies were accepted for use in these analyses.

Peak discharges for the Androscoggin River in Peru were established by adjusting the peak discharge reported in the Rumford and Lewiston studies using the following formula:

$$Q = Q_f (A/A_f)^b$$

where Q is the unknown discharge at the desired site, Q_f is the discharge as reported in the Flood Insurance Studies for Rumford or Lewiston, A and A_f are the drainage areas at the appropriate sites, and b is an exponent. The exponent, b , was computed on the basis of the peak discharges and drainage areas for the Androscoggin River as reported in the Rumford or Lewiston studies. For floods of the 100-year recurrence interval, the value of b was found to be 0.81.

A summary of the drainage area-peak discharge relationships for the flooding sources studied by detailed methods is shown in Table 1, "Summary of Discharges."

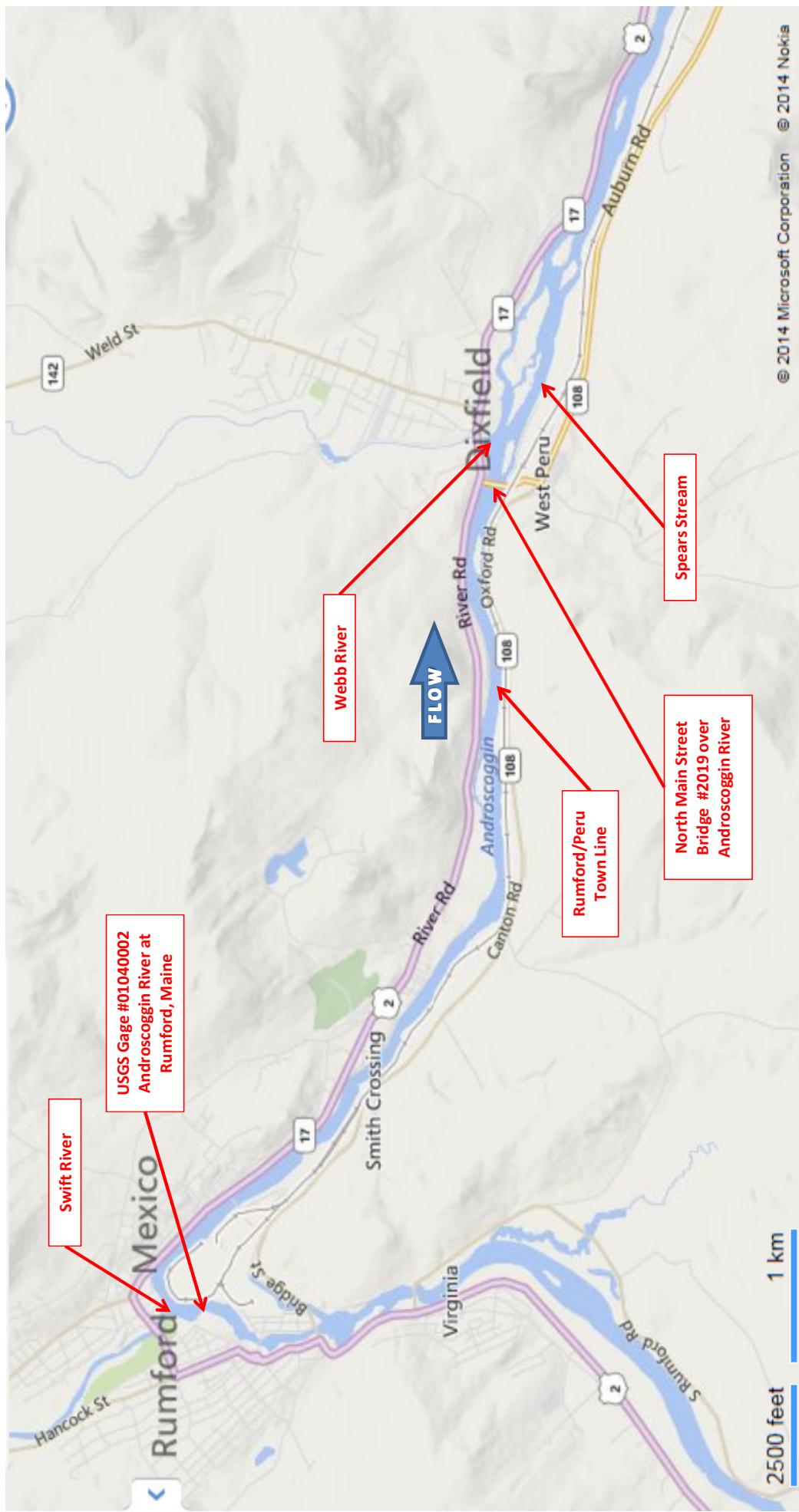
TABLE 1 - SUMMARY OF DISCHARGES

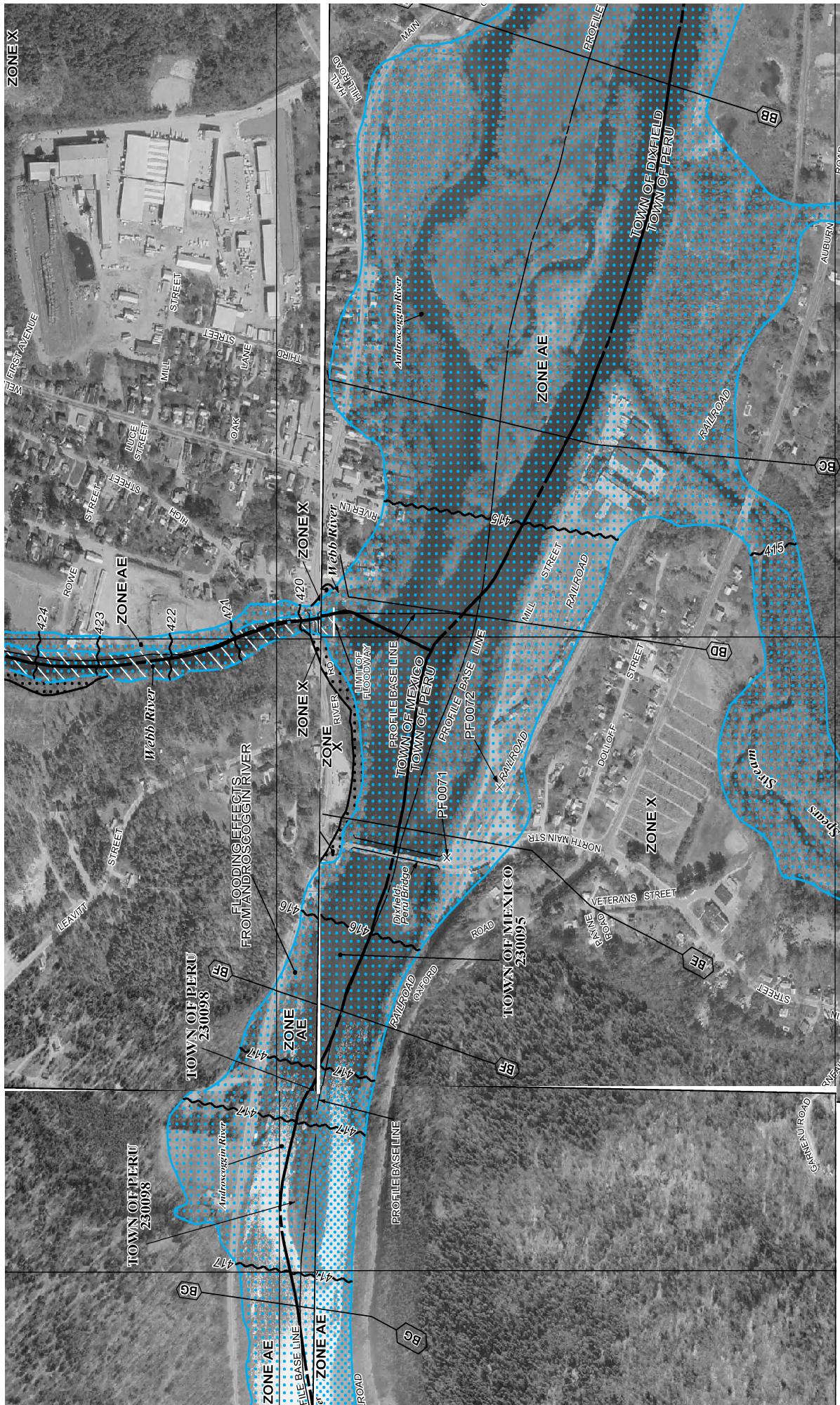
<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (sq. miles)</u>	<u>PEAK DISCHARGE (cfs) 100-YEAR</u>
ANDROSCOGGIN RIVER		
At Riley Dam	2,466	85,200
Upstream of confluence of Spears Stream	2,336	81,500
Upstream of confluence of Webb River	2,204	78,000

Peak discharge-drainage area relationships for the Androscoggin, Swift, and Webb Rivers are shown in Table 1.

Table 1. Summary of Discharges

<u>Flooding Source and Location</u>	<u>Drainage Area (Square Miles)</u>	Peak Discharges (Cubic Feet per Second)			
		10-Year	50-Year	100-Year	500-Year
Androscoggin River					
At Rumford-Peru town line	2,210	51,000	68,600	78,000	98,600
Above Mouth of Swift River	2,070	40,300	55,400	62,500	80,000
Swift River					
At Mouth	124	14,600	24,400	29,500	43,800
Webb River					
At Mouth	133	4,510	6,800	7,800	10,000





FLOOD CRESTS

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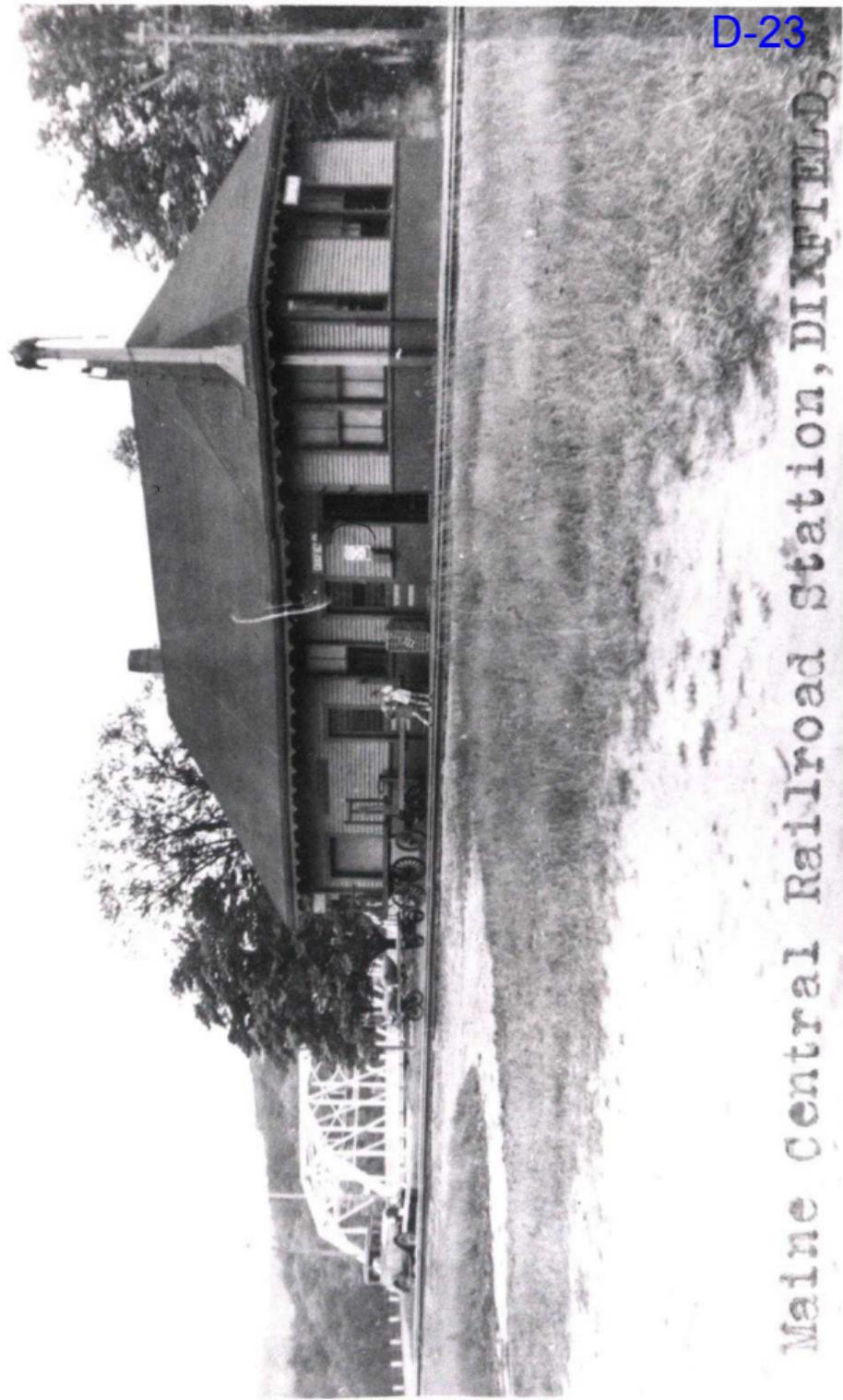
Table 15.-Flood crest stages--Continued

Stream and location	Miles above mouth	Date and time	Altitude in feet
<u>Androscoggin River Basin--Continued</u>			
Androscoggin River--Continued:			
Rumford Point, Maine, dwelling house, left bank	96.9	Mar.19	631.4
Rumford Point, Maine, 0.9 mile below, "The Pines" roadside stand, left bank	96.0	Mar.19	630.2
Rumford Point, Maine, 2.6 miles below, "Pine Hill" farm, left bank	94.3	Mar.19	629.8
Rumford Center, Maine, 0.6 mile above, left bank	93.2	Mar.19 7-11pm	628.2
Rumford Center, Maine, 3 miles below, near mouth of Zircon Brook, left bank	89.9	Mar.19	626.6
Virginia, Maine, 1 mile above, Virgil Abbott barn, left bank	89.0	Mar.19	624.8
Rumford, Maine, 550 feet above upper dam of Rumford Falls Power Co., left bank	87.5	Mar.19 midnight	623.1
Rumford, Maine, upper dam, headwater, left bank	87.4	Mar.20 12-lam	qq613.3
Rumford, Maine, just below upper dam	87.4	Mar.20	581.7
Rumford, Maine, 0.05 mile below upper dam	87.4	Mar.20	567.0
Rumford, Maine, 0.1 mile below upper dam	87.3	Mar.20	516.7
Rumford, Maine, middle dam of Rumford Falls Power Co. headwater, right bank	87.2	Mar.20	rr514.5
Rumford, Maine, middle dam, tailwater, left bank	87.1	Mar.20	501.7
Rumford, Maine, 0.1 mile below middle dam, left bank	87.0	Mar.20	491.7
Rumford, Maine, 0.2 mile below middle dam, left bank	86.9	Mar.20	466.7
Rumford, Maine, concrete arch Memorial Bridge, left bank	86.8	Mar.20	448.0
Mexico, Maine, mouth of Swift River, left bank	86.3	Mar.20	444.6
Mexico, Maine, tree near Library building, left bank	86.2	Mar.20	444.1
Ridlonville, Maine, barber shop, left bank	85.8	Mar.20	437.8
Mexico, Maine, 1.5 miles below, opposite Smith's crossing, left bank	84.8	Mar.20	433.0
Mexico, Maine, 2.5 miles below, Riverside Park, left bank	83.8	Mar.20	424.4
Dixfield, Maine, 1.4 miles above, head of second island above highway bridge, left bank	83.4	Mar.20	423.7
Dixfield, Maine, <u>Maine Central R.R. Co. station,</u> <u>copper plate, left bank</u>	82.0	Mar.20 2am	417.5
Dixfield, Maine, <u>mouth of Webb River, right bank</u>	81.8	Mar.20	417.2
Dixfield, Maine, 1.4 miles below, near mouth of small brook, right bank	80.6	Mar.20	415.2
Dixfield, Maine, 2.1 miles below, near lower end of island, right bank	79.9	Mar.20	410.8
Peru, Maine, 0.5 mile below, head of Green Island, right bank	78.0	Mar.20	407.9
East Peru, Maine, near <u>Maine Central R.R. Co.</u> <u>station, right bank</u>	76.6	Mar.20	406.2
East Peru, Maine, mouth of Worthley Brook, right bank	76.3	Mar.20	406.0
Gilbertville, Maine, highway bridge, left bank	71.7	Mar.20	397.4
Gilbertville, Maine, 3.0 miles below, near Stevens	68.7	Mar.20	395.5

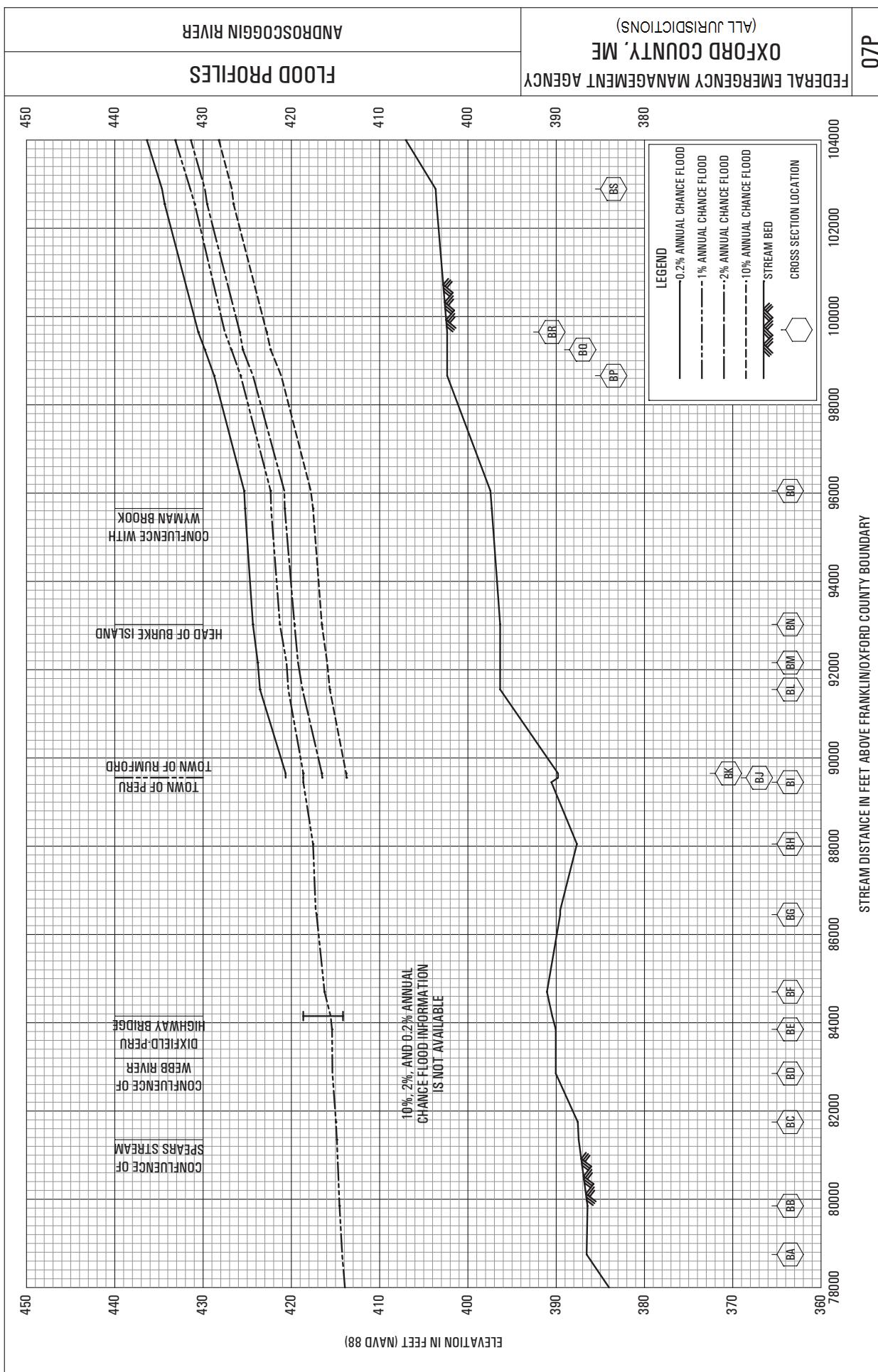
Table 12.--Flood-crest stages for April 1987 flood in Maine--Continued

Stream and location		Miles upstream ^a from mouth	Elevation (in feet)
<u>ANDROSCOGGIN RIVER BASIN--Continued</u>			
Androscoggin River--Continued:			
Rumford, Maine, 100 feet downstream from South Rumford Road bridge, right bank	87.5	609.1	
Rumford, Maine, Upper dam,	headwater	87.4	607.8 ^{r,s}
	tailwater	87.4	509.1 ^s
Rumford, Maine, Middle dam,	headwater	87.2	509.1 ^{s,t}
Rumford, Maine, 50 feet upstream from Morse Bridge, left bank		87.1	502.7
Rumford, Maine, 75 feet downstream from Morse Bridge, left bank		87.1	501.4
Rumford, Maine, U.S. Geological Survey station 01054500, 1,000 feet upstream from mouth of Swift River, right bank		86.5	443.2
Mexico, Maine, 100 feet downstream from mouth of Swift River, left bank		86.3	441.9
Mexico, Maine, 30 feet upstream from footbridge, left bank		85.8	437.5
Mexico, Maine, 30 feet downstream from footbridge, left bank		85.8	436.3
Mexico, Maine, 75 feet upstream from Ridlonville Bridge, left bank		85.6	435.8
Mexico, Maine, 75 feet downstream from Ridlonville Bridge, left bank		85.6	435.4
Dixfield, Maine, downstream side highway bridge, left bank	82.0	415.1	
Canton, Maine, 1.7 miles upstream from Route 140 bridge, left bank	73.4	396.9	

D-23



Maine Central Railroad Station, DIXFIELD,



FLOODING SOURCE	CROSS SECTION	FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
		DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY
BC	81,745	1,850	25,000	3.3	415.0	*	*	*
BD	82,845	1,490	25,000	3.3	415.3	*	*	*
BE	83,830	1,050	16,100	4.8	415.4	*	*	*
BF	84,695	700	14,100	5.5	416.4	*	*	*
BG	86,465	880	15,000	5.2	417.2	*	*	*
BH	88,045	500	9,150	8.5	417.7	*	*	*
BI	89,445	380	7,480	10.4	418.8	*	*	*
BJ	89,545	310	7,530	10.4	418.8	417.8	418.7	0.9
BK	89,645	310	7,570	10.3	418.8	418.0	418.8	0.8
BL	91,545	870	16,600	4.7	420.4	420.4	421.3	0.9
BM	92,185	810	14,300	5.5	420.7	420.7	421.6	0.9
BN	93,025	810	17,200	4.5	421.3	421.3	422.1	0.8
BO	96,045	350	8,030	9.7	422.4	422.4	423.2	0.8
BP	98,665	340	7,140	10.9	425.8	425.8	426.7	0.9
BQ	99,245	340	7,500	10.4	426.9	426.9	427.7	0.8
BR	99,675	340	7,730	10.1	427.6	427.6	428.4	0.8
BS	102,895	330	7,770	10.0	431.5	431.5	432.4	0.9
BT	104,225	510	10,700	7.3	433.6	433.6	434.4	0.8
BU	105,555	320	6,270	12.4	434.4	434.4	435.2	0.8
BV	105,665	320	6,370	12.2	434.7	434.7	435.5	0.8
BW	105,955	320	6,880	11.4	436.1	436.1	436.9	0.8
BX	106,305	370	8,320	9.4	437.2	437.2	438.0	0.8
BY	106,485	370	9,110	8.6	437.5	437.5	438.4	0.9
BZ	106,715	370	9,230	8.5	437.9	437.9	438.7	0.8
CA	107,665	370	9,630	8.1	438.7	438.7	439.5	0.8
CB	108,945	400	10,300	7.6	439.6	439.6	440.3	0.7
CC	109,375	400	12,900	4.9	440.6	440.6	441.0	0.4

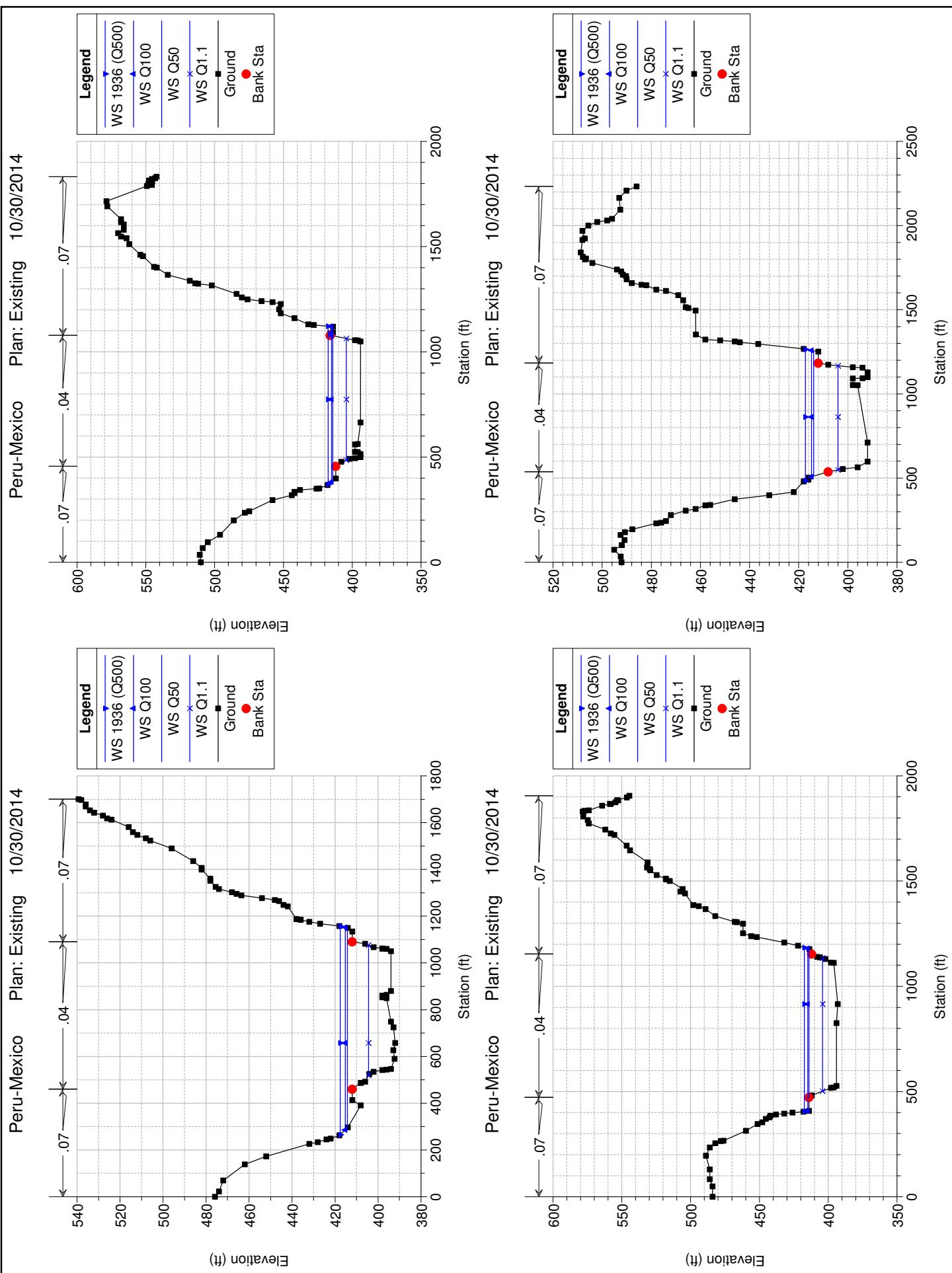
¹ FEET ABOVE FRANKLIN / OXFORD COUNTY BOUNDARY
 * NO FLOODWAY DATA IS AVAILABLE FOR THIS CROSS-SECTION. INFORMATION SHOWN IS FOR 1% ANNUAL CHANCE FLOOD.

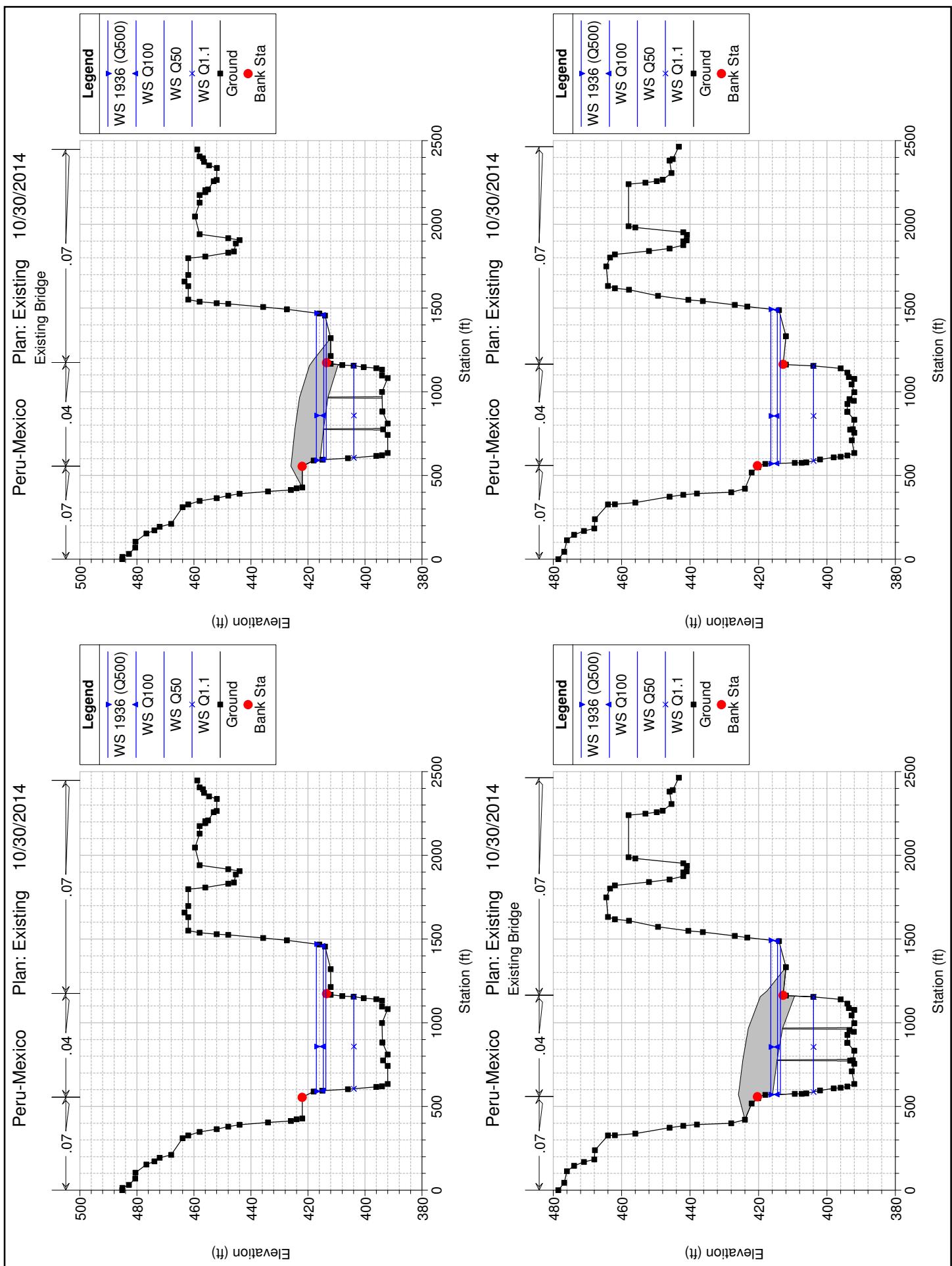
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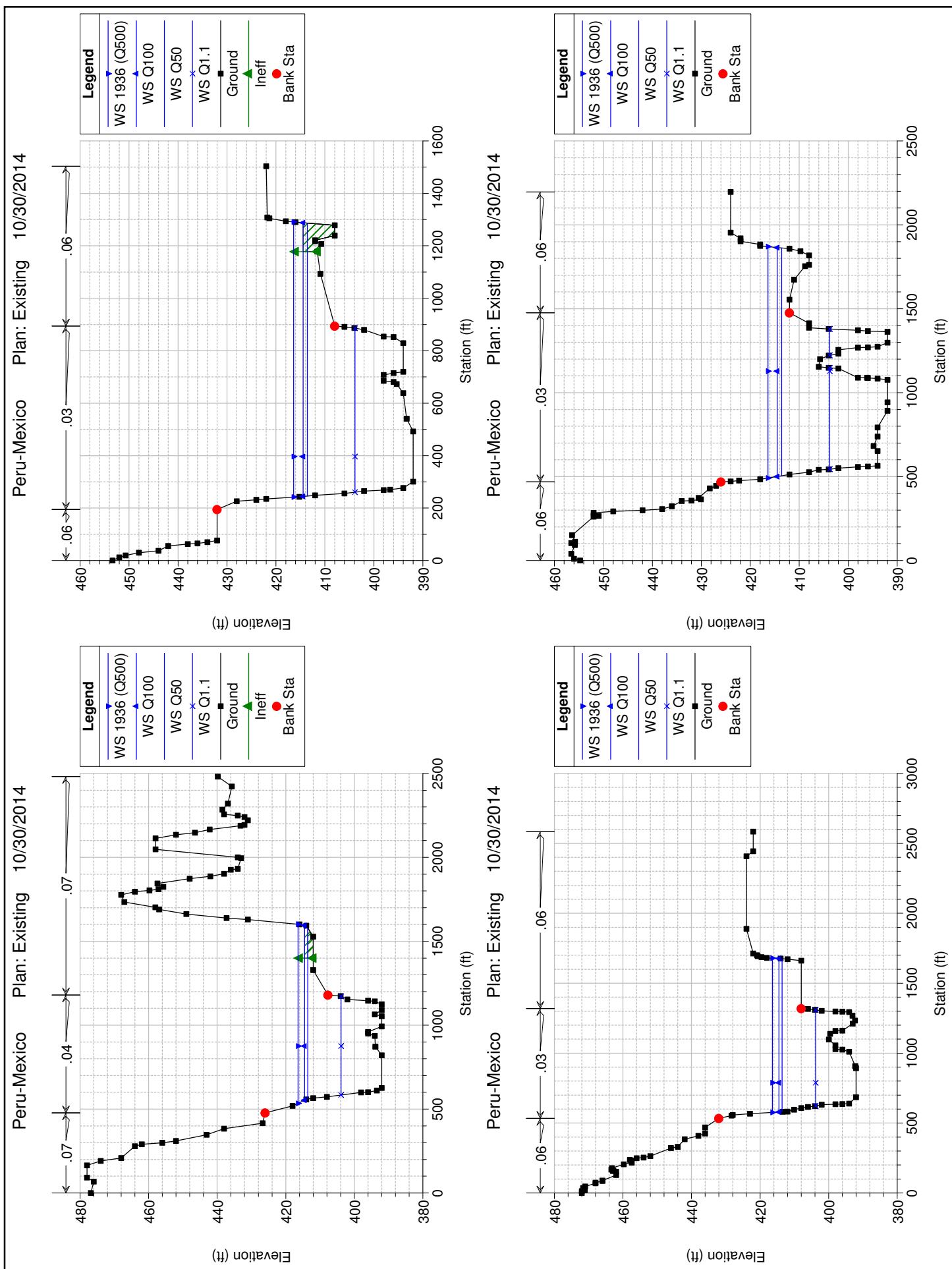
FEDERAL EMERGENCY MANAGEMENT AGENCY
OXFORD COUNTY, ME
 ALL JURISDICTIONS

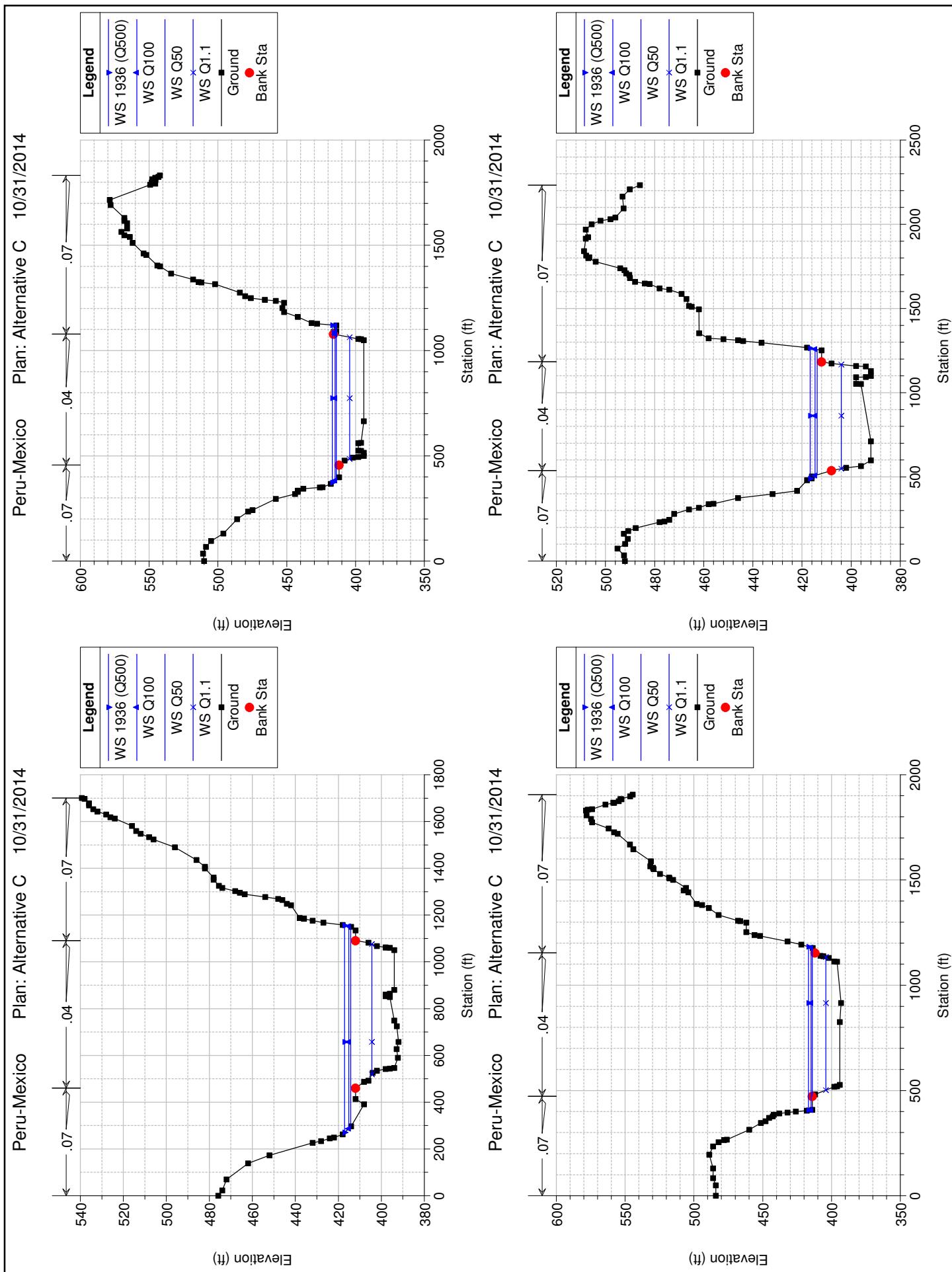
FLOODWAY DATA

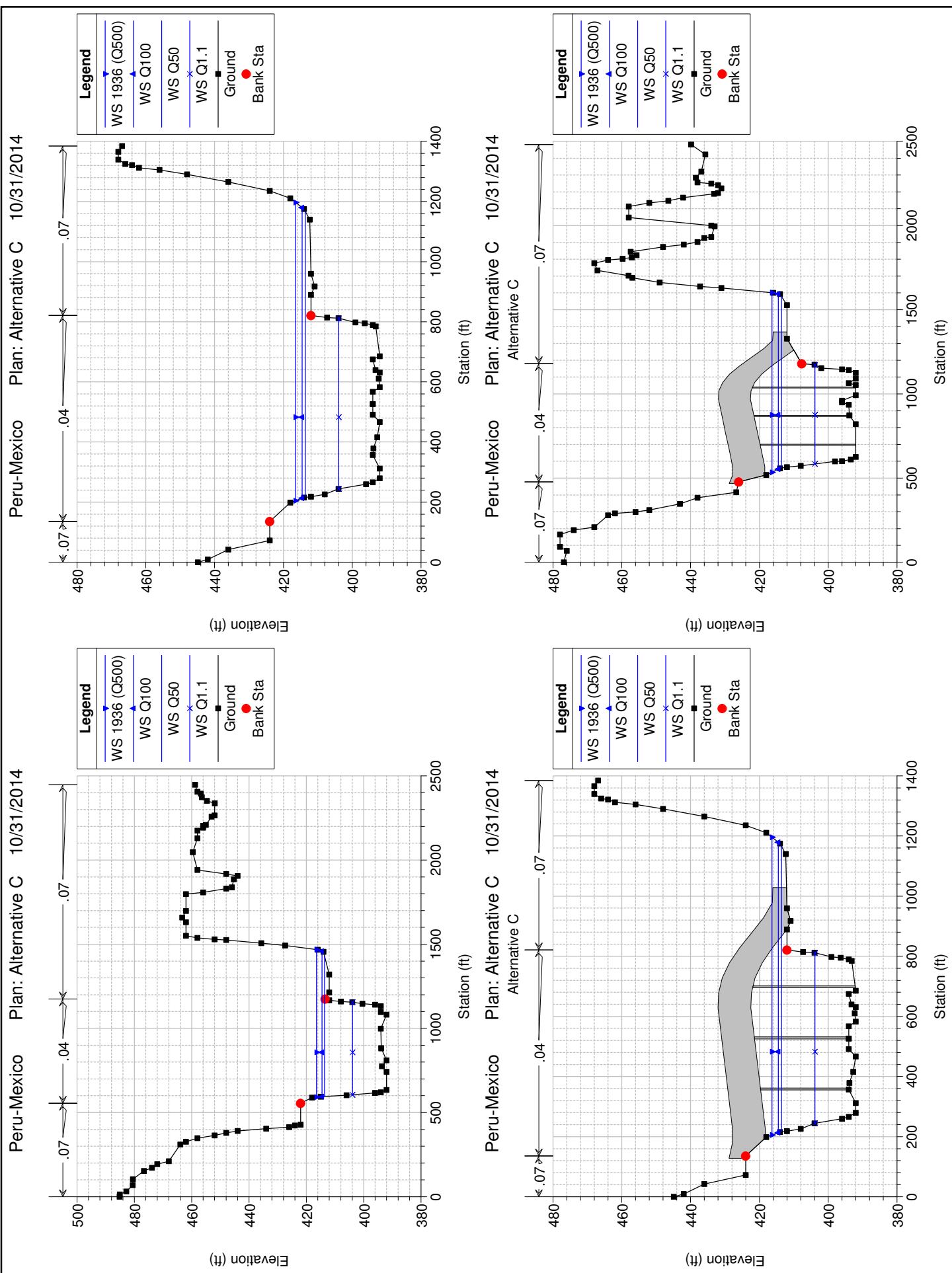
ANDROSCOGGIN RIVER

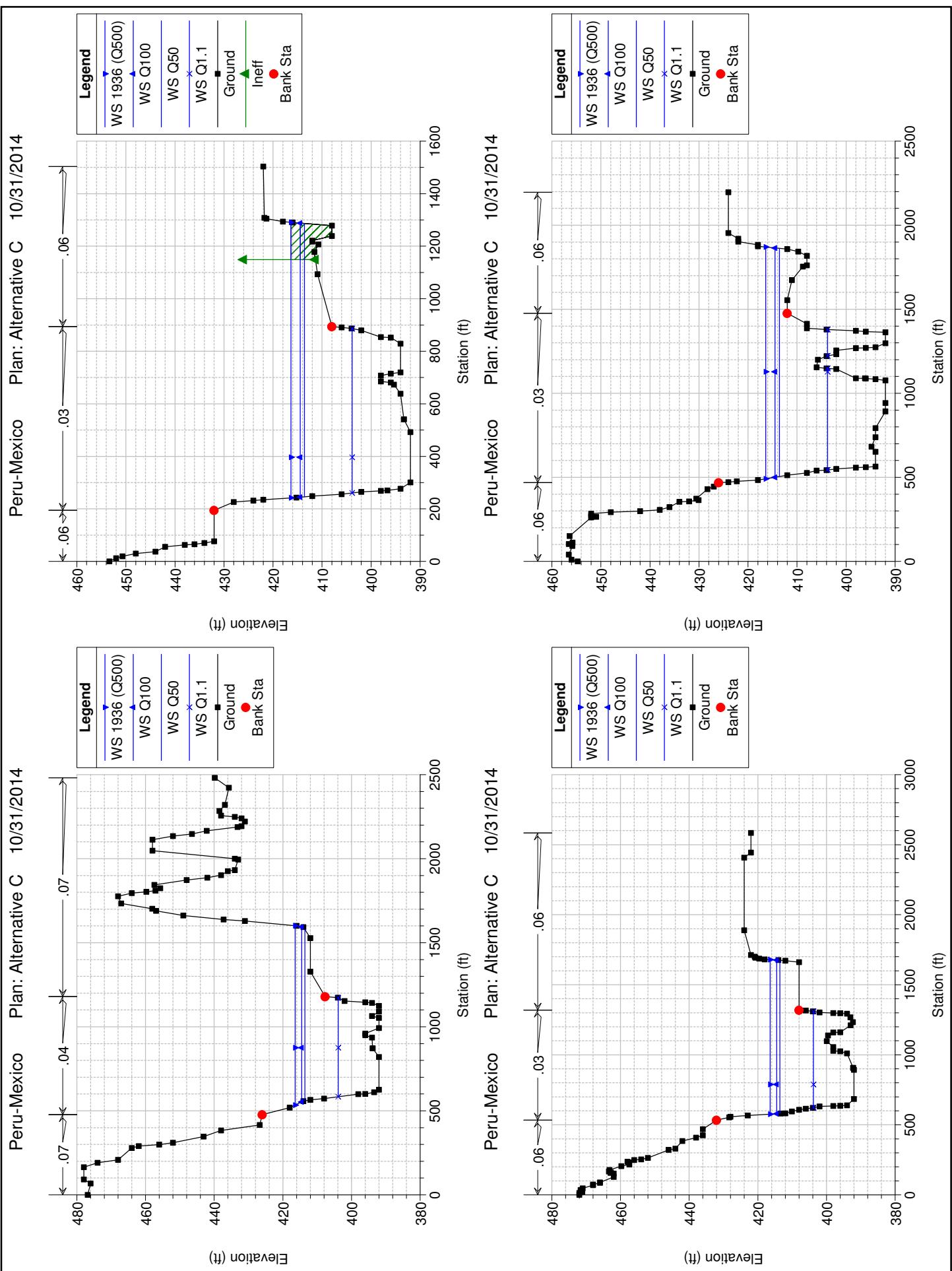












HEC-RAS	River: Stream	Reach: Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach	2012.492	Q10		Existing	47180.00	392.00	411.70		412.05	0.000419	4.74	10074.24	707.48		0.21
Reach	2012.492	Q10	Alt C	Existing	47180.00	392.00	411.70		412.04	0.000420	4.74	10070.38	707.32		0.21
Reach	2012.492	Q25		Existing	55409.00	392.00	413.25		413.64	0.000423	5.06	11310.90	835.95		0.21
Reach	2012.492	Q25	Alt C	Existing	55409.00	392.00	413.22		413.62	0.000425	5.06	11290.06	835.36		0.21
Reach	2012.492	Q50		Existing	61408.00	392.00	414.25		414.68	0.000428	5.28	12157.99	856.35		0.22
Reach	2012.492	Q50	Alt C	Existing	61408.00	392.00	414.20		414.63	0.000431	5.29	12117.60	855.85		0.22
Reach	2012.492	Q100		Existing	67324.00	392.00	415.19		415.65	0.000431	5.48	12973.97	866.25		0.22
Reach	2012.492	Q100	Alt C	Existing	67324.00	392.00	415.11		415.58	0.000437	5.50	12904.72	865.41		0.22
Reach	2012.492	Q500		Existing	80942.00	392.00	417.64		418.15	0.000409	5.78	15123.08	891.81		0.22
Reach	2012.492	Q500	Alt C	Existing	80942.00	392.00	417.08		417.62	0.000448	5.95	14630.47	886.02		0.23
Reach	2012.492	1987 (Q200)		Existing	69885.00	392.00	415.60		416.07	0.000432	5.56	13324.38	870.47		0.22
Reach	2012.492	1987 (Q200)	Alt C	Existing	69885.00	392.00	415.50		415.98	0.000439	5.59	13239.21	869.45		0.22
Reach	2012.492	1936 (Q500)		Existing	80745.00	392.00	417.61		418.12	0.000403	5.77	15101.58	891.56		0.22
Reach	2012.492	1936 (Q500)	Alt C	Existing	80745.00	392.00	417.06		417.60	0.000447	5.94	14611.73	885.80		0.23
Reach	2012.492	Q1.1		Existing	18963.0	392.00	404.38		404.56	0.000403	3.42	5543.90	556.76	0.19	
Reach	2012.492	Q1.1	Alt C	Existing	18963.0	392.00	404.38		404.57	0.000402	3.42	5544.56	5556.79	0.19	
Reach	1657.293	Q10		Existing	47180.00	394.00	411.54		411.90	0.000424	4.79	9841.64	614.31		0.21
Reach	1657.293	Q10	Alt C	Existing	47180.00	394.00	411.54		411.89	0.000425	4.80	9838.17	614.28		0.21
Reach	1657.293	Q25		Existing	55409.00	394.00	413.08		413.49	0.000435	5.13	10856.45	662.53		0.22
Reach	1657.293	Q25	Alt C	Existing	55409.00	394.00	413.05		413.46	0.000437	5.14	10838.94	682.36		0.22
Reach	1657.293	Q50		Existing	61408.00	394.00	414.07		414.52	0.000445	5.38	11537.65	717.17		0.22
Reach	1657.293	Q50	Alt C	Existing	61408.00	394.00	414.02		414.47	0.000448	5.39	11502.86	716.73		0.22
Reach	1657.293	Q100		Existing	67324.00	394.00	415.01		415.49	0.000453	5.60	12214.86	725.71		0.22
Reach	1657.293	Q100	Alt C	Existing	67324.00	394.00	414.93		415.42	0.000459	5.63	12155.18	724.96		0.23
Reach	1657.293	Q500		Existing	80942.00	394.00	417.45		417.99	0.000438	5.95	14018.78	751.60		0.23
Reach	1657.293	Q500	Alt C	Existing	80942.00	394.00	416.88		417.45	0.000479	6.12	13591.69	748.32		0.23
Reach	1657.293	1987 (Q200)		Existing	69885.00	394.00	415.41		415.91	0.000456	5.69	12505.84	729.35		0.23
Reach	1657.293	1987 (Q200)	Alt C	Existing	69885.00	394.00	415.31		415.81	0.000464	5.72	12432.46	728.43		0.23
Reach	1657.293	1936 (Q500)		Existing	80745.00	394.00	417.42		417.97	0.000437	5.94	14000.96	751.46		0.23
Reach	1657.293	1936 (Q500)	Alt C	Existing	80745.00	394.00	416.85		417.43	0.000479	6.11	13576.23	748.20		0.23
Reach	1657.293	Q1.1		Existing	18963.0	394.00	404.23		404.42	0.000435	3.45	5503.80	577.44	0.20	
Reach	1657.293	Q1.1	Alt C	Existing	18963.0	394.00	404.23		404.42	0.000435	3.44	5504.52	577.45		
Reach	1328.103	Q10		Existing	47180.00	393.00	411.46		411.76	0.000339	4.35	10845.39	669.17		0.19
Reach	1328.103	Q10	Alt C	Existing	47180.00	393.00	411.46		411.75	0.000340	4.35	10841.55	669.14		0.19
Reach	1328.103	Q25		Existing	55409.00	393.00	413.00		413.34	0.000351	4.66	11888.82	690.97		0.20
Reach	1328.103	Q25	Alt C	Existing	55409.00	393.00	412.98		413.31	0.000352	4.67	11870.78	690.49		0.20
Reach	1328.103	Q50		Existing	61408.00	393.00	413.99		414.36	0.000361	4.89	12582.04	705.12		0.20
Reach	1328.103	Q50	Alt C	Existing	61408.00	393.00	413.94		414.32	0.000365	4.90	12547.22	704.81		0.20
Reach	1328.103	Q100		Existing	67324.00	393.00	414.93		415.34	0.000368	5.10	13306.27	772.14		0.20
Reach	1328.103	Q100	Alt C	Existing	67324.00	393.00	414.85		415.26	0.000373	5.12	13241.64	771.89		0.21
Reach	1328.103	Q500		Existing	80942.00	393.00	417.38		417.83	0.000355	5.43	15204.13	779.33		0.20
Reach	1328.103	Q500	Alt C	Existing	80942.00	393.00	416.80		417.28	0.000389	5.58	14754.24	777.63		0.21

HEC-RAS River: Stream Reach: Reach (Continued)

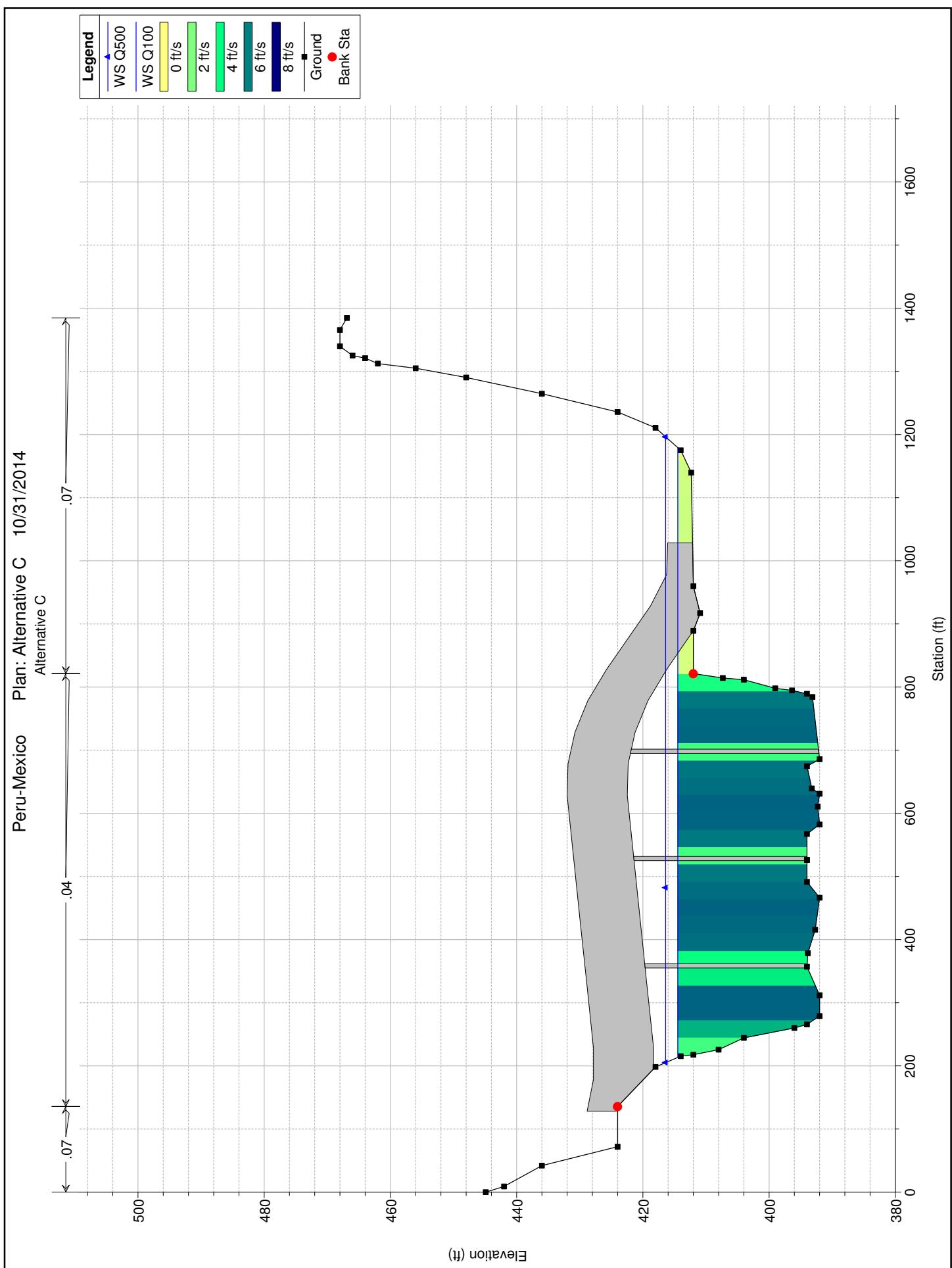
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach	1328.103	1987 (Q200)	Existing	69885.00	393.00	415.33	415.75	0.000370	5.18	13615.99	773.32	0.21	
Reach	1328.103	1987 (Q200)	Alt C	69885.00	393.00	415.23	415.65	0.000376	5.21	13536.80	773.02	0.21	
Reach	1328.103	1936 (Q500)	Existing	80745.00	393.00	417.36	417.81	0.000355	5.42	15185.65	779.26	0.20	
Reach	1328.103	1936 (Q500)	Alt C	80745.00	393.00	416.78	417.26	0.000389	5.57	14738.22	777.57	0.21	
Reach	1328.103	Q1.1	Existing	18963.00	393.00	404.13	404.28	0.000347	3.12	6084.97	632.34	0.18	
Reach	1328.103	Q1.1	Alt C	18963.00	393.00	404.13	404.28	0.000347	3.12	6085.80	632.35	0.18	
Reach	1026.613	Q10	Existing	47180.00	392.00	411.36	411.66	0.000328	4.36	10851.15	658.46	0.19	
Reach	1026.613	Q10	Alt C	47180.00	392.00	411.35	411.65	0.000328	4.36	10847.31	658.42	0.19	
Reach	1026.613	Q25	Existing	55409.00	392.00	412.89	413.23	0.000338	4.68	11930.16	737.43	0.19	
Reach	1026.613	Q25	Alt C	55409.00	392.00	412.87	413.21	0.000340	4.69	11910.52	737.24	0.19	
Reach	1026.613	Q50	Existing	61408.00	392.00	413.88	414.26	0.000348	4.92	12661.37	744.44	0.20	
Reach	1026.613	Q50	Alt C	61408.00	392.00	413.83	414.21	0.000351	4.93	12623.89	744.08	0.20	
Reach	1026.613	Q100	Existing	67324.00	392.00	414.82	415.23	0.000356	5.14	13361.76	751.10	0.20	
Reach	1026.613	Q100	Alt C	67324.00	392.00	414.73	415.14	0.000361	5.16	13297.70	750.49	0.20	
Reach	1026.613	Q500	Existing	80942.00	392.00	417.26	417.73	0.000349	5.49	15233.71	781.07	0.20	
Reach	1026.613	Q500	Alt C	80942.00	392.00	416.67	417.17	0.000382	5.64	14775.60	775.71	0.21	
Reach	1026.613	1987 (Q200)	Existing	69885.00	392.00	415.22	415.64	0.000359	5.23	13662.26	753.94	0.20	
Reach	1026.613	1987 (Q200)	Alt C	69885.00	392.00	415.11	415.54	0.000365	5.25	13583.61	753.19	0.20	
Reach	1026.613	1936 (Q500)	Existing	80745.00	392.00	417.24	417.70	0.000348	5.48	15215.33	780.85	0.20	
Reach	1026.613	1936 (Q500)	Alt C	80745.00	392.00	416.65	417.14	0.000381	5.63	14759.81	775.53	0.21	
Reach	1026.613	Q1.1	Existing	18963.00	392.00	404.03	404.18	0.000323	3.07	6186.51	618.71	0.17	
Reach	1026.613	Q1.1	Alt C	18963.00	392.00	404.03	404.18	0.000323	3.06	6187.36	618.72	0.17	
Reach	799.9457	Q10	Existing	47180.00	392.00	411.21	399.39	411.57	0.000381	4.79	9843.54	568.39	0.20
Reach	799.9457	Q10	Alt C	47180.00	392.00	411.21	411.56	0.000382	4.79	9840.14	568.37	0.20	
Reach	799.9457	Q25	Existing	55409.00	392.00	412.73	400.09	413.14	0.000403	5.17	10812.58	750.62	0.21
Reach	799.9457	Q25	Alt C	55409.00	392.00	412.70	413.12	0.000405	5.18	10792.10	747.89	0.21	
Reach	799.9457	Q50	Existing	61408.00	392.00	413.70	400.59	414.16	0.000421	5.43	11591.44	840.16	0.22
Reach	799.9457	Q50	Alt C	61408.00	392.00	413.65	414.11	0.000424	5.45	11548.05	836.62	0.22	
Reach	799.9457	Q100	Existing	67324.00	392.00	414.63	401.07	415.13	0.000431	5.66	12389.38	864.84	0.22
Reach	799.9457	Q100	Alt C	67324.00	392.00	414.55	415.05	0.000437	5.69	12313.29	864.23	0.22	
Reach	799.9457	Q500	Existing	80942.00	392.00	417.08	402.11	417.64	0.000419	6.00	14527.35	878.76	0.22
Reach	799.9457	Q500	Alt C	80942.00	392.00	416.48	417.06	0.000461	6.19	13994.30	876.54	0.23	
Reach	799.9457	1987 (Q200)	Existing	69885.00	392.00	415.03	401.27	415.54	0.000434	5.76	12733.30	867.62	0.22
Reach	799.9457	1987 (Q200)	Alt C	69885.00	392.00	414.92	415.44	0.000442	5.79	12639.90	866.86	0.22	
Reach	799.9457	1936 (Q500)	Existing	80745.00	392.00	417.06	402.10	417.62	0.000419	5.99	14506.86	878.68	0.22
Reach	799.9457	1936 (Q500)	Alt C	80745.00	392.00	416.46	417.04	0.000460	6.18	13976.81	876.47	0.23	
Reach	799.9457	Q1.1	Existing	18963.00	392.00	403.93	396.53	404.10	0.000345	3.28	5775.07	549.99	0.18
Reach	799.9457	Q1.1	Alt C	18963.00	392.00	403.93	404.10	0.000344	3.28	5775.88	549.99	0.18	
Reach	777.7		Bridge										
Reach	755.4108	Q10	Existing	47180.00	392.00	411.18	411.51	0.000356	4.64	10177.77	588.01	0.20	

HEC-RAS River: Stream Reach: Reach (Continued)

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	
Reach	755.4108	Q25	Existing	55409.00	392.00	412.67		413.06	0.000376	5.01	11120.14	780.79	0.20	
Reach	755.4108	Q50	Existing	61408.00	392.00	413.61		414.05	0.000392	5.27	11920.83	885.02	0.21	
Reach	755.4108	Q100	Existing	67324.00	392.00	414.50		414.97	0.000404	5.51	12728.16	916.84	0.21	
Reach	755.4108	Q500	Existing	80942.00	392.00	416.42		416.97	0.000427	6.00	14489.52	922.45	0.22	
Reach	755.4108	1987 (Q200)	Existing	69885.00	392.00	414.88		415.36	0.000409	5.61	13072.21	917.94	0.22	
Reach	755.4108	1936 (Q500)	Existing	80745.00	392.00	416.40		416.95	0.000426	5.99	14471.28	922.40	0.22	
Reach	755.4108	Q1.1	Existing	18963.00	392.00	403.91		404.07	0.000322	3.18	5958.20	567.19	0.17	
Reach	707.4286	Q10	Alt C	47180.00	392.00	411.19		399.23	411.52	0.000361	4.62	10212.67	617.28	0.20
Reach	707.4286	Q25	Alt C	55409.00	392.00	412.69		399.94	413.07	0.000378	4.98	11340.81	930.14	0.20
Reach	707.4286	Q50	Alt C	61408.00	392.00	413.64		414.06	0.000391	5.23	12238.22	951.46	0.21	
Reach	707.4286	Q100	Alt C	67324.00	392.00	414.54		414.99	0.000402	5.45	13098.11	966.56	0.21	
Reach	707.4286	Q500	Alt C	80942.00	392.00	416.47		401.93	417.00	0.000424	5.90	14995.10	992.15	0.22
Reach	707.4286	1987 (Q200)	Alt C	69885.00	392.00	414.92		401.10	415.39	0.000407	5.54	13465.03	971.57	0.22
Reach	707.4286	1936 (Q500)	Alt C	80745.00	392.00	416.45		401.91	416.98	0.000424	5.89	14975.18	991.88	0.22
Reach	707.4286	Q1.1	Alt C	18963.00	392.00	403.91		396.39	404.06	0.000325	3.19	5946.55	567.01	0.17
Reach	652.4912	Q10	Existing	47180.00	392.00	411.15		398.94	411.46	0.000330	4.46	10760.22	732.28	0.19
Reach	652.4912	Q10	Alt C	47180.00	392.00	411.16		411.46	0.000330	4.46	10762.59	732.40	0.19	
Reach	652.4912	Q25	Existing	55409.00	392.00	412.65		399.64	413.00	0.000346	4.80	11933.85	985.39	0.20
Reach	652.4912	Q25	Alt C	55409.00	392.00	412.65		413.01	0.000346	4.80	12027.13	985.55	0.20	
Reach	652.4912	Q50	Existing	61408.00	392.00	413.60		400.11	413.99	0.000360	5.05	12729.72	1020.23	0.20
Reach	652.4912	Q50	Alt C	61408.00	392.00	413.60		413.99	0.000359	5.04	12979.93	1020.44	0.20	
Reach	652.4912	Q100	Existing	67324.00	392.00	414.48		400.58	414.91	0.000375	5.27	13479.58	1041.74	0.21
Reach	652.4912	Q100	Alt C	67324.00	392.00	414.49		414.91	0.000372	5.25	13900.77	1041.85	0.21	
Reach	652.4912	Q25	Existing	80942.00	392.00	416.41		401.60	416.89	0.000398	5.66	15922.65	1067.26	0.22
Reach	652.4912	Q25	Alt C	80942.00	392.00	416.41		416.90	0.000398	5.66	15927.67	1067.31	0.22	
Reach	652.4912	Q500	Existing	69885.00	392.00	414.86		400.78	415.30	0.000381	5.36	13798.25	1046.89	0.21
Reach	652.4912	Q500	Alt C	69885.00	392.00	414.87		415.30	0.000377	5.33	14293.80	1047.01	0.21	
Reach	652.4912	1936 (Q500)	Existing	80745.00	392.00	416.39		401.59	416.87	0.000397	5.66	15901.48	1067.03	0.22
Reach	652.4912	1936 (Q500)	Alt C	80745.00	392.00	416.39		416.87	0.000397	5.65	15906.53	1067.08	0.22	
Reach	652.4912	Q1.1	Existing	18963.00	392.00	403.88		396.11	404.03	0.000304	3.08	6164.29	588.78	0.17
Reach	652.4912	Q1.1	Alt C	18963.00	392.00	403.88		404.03	0.000304	3.08	6164.45	588.79	0.17	
Reach	500.5752	Q10	Existing	47180.00	392.00	411.13		399.38	411.42	0.000182	4.34	11167.91	946.67	0.19
Reach	500.5752	Q10	Alt C	47180.00	392.00	411.13		399.38	411.42	0.000182	4.34	11167.91	946.67	0.19
Reach	500.5752	Q25	Existing	55409.00	392.00	412.62		400.05	412.96	0.000188	4.66	12547.28	1038.15	0.19
Reach	500.5752	Q25	Alt C	55409.00	392.00	412.62		400.05	412.96	0.000188	4.66	12512.99	1038.15	0.19
Reach	500.5752	Q50	Existing	61408.00	392.00	413.57		400.52	413.94	0.000193	4.88	13432.04	1041.04	0.20
Reach	500.5752	Q50	Alt C	61408.00	392.00	413.57		400.51	413.94	0.000194	4.88	13369.96	1041.04	0.20
Reach	500.5752	Q100	Existing	67324.00	392.00	414.46		400.95	414.86	0.000199	5.09	14262.37	1043.75	0.20
Reach	500.5752	Q100	Alt C	67324.00	392.00	414.46		400.95	414.86	0.000199	5.09	14174.17	1043.75	0.20
Reach	500.5752	Q500	Existing	80942.00	392.00	416.39		401.94	416.84	0.000204	5.47	16781.75	1049.37	0.21
Reach	500.5752	Q500	Alt C	80942.00	392.00	416.38		401.94	416.84	0.000210	5.54	15910.36	1049.34	0.21

HEC-RAS River: Stream Reach: Reach (Continued)

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach	500.5752	1987 (Q200)	Existing	69885.00	392.00	414.84	401.16	415.25	0.000201	5.18	14613.23	1044.90	0.20
Reach	500.5752	1987 (Q200)	Alt C	69885.00	392.00	414.84	401.16	415.25	0.000201	5.18	14514.00	1044.89	0.20
Reach	500.5752	1936 (Q500)	Existing	80745.00	392.00	416.37	401.93	416.82	0.000204	5.46	16761.00	1049.31	0.21
Reach	500.5752	1936 (Q500)	Alt C	80745.00	392.00	416.36	401.92	416.82	0.000209	5.53	15892.50	1049.28	0.21
Reach	500.5752	Q1.1	Existing	18963.00	392.00	403.85	396.56	403.99	0.000183	3.06	6188.93	625.68	0.17
Reach	500.5752	Q1.1	Alt C	18963.00	392.00	403.85	396.55	403.99	0.000183	3.06	6188.93	625.68	0.17
Reach	327.0046	Q10	Existing	47180.00	392.00	411.13		411.37	0.000162	3.97	12783.47	1081.46	0.17
Reach	327.0046	Q10	Alt C	47180.00	392.00	411.13		411.37	0.000162	3.97	12783.47	1081.46	0.17
Reach	327.0046	Q25	Existing	55409.00	392.00	412.64		412.91	0.000164	4.22	14421.04	1091.63	0.18
Reach	327.0046	Q25	Alt C	55409.00	392.00	412.64		412.91	0.000164	4.22	14421.04	1091.63	0.18
Reach	327.0046	Q50	Existing	61408.00	392.00	413.59		413.89	0.000167	4.40	15465.29	1094.43	0.18
Reach	327.0046	Q50	Alt C	61408.00	392.00	413.59		413.89	0.000167	4.40	15465.29	1094.43	0.18
Reach	327.0046	Q100	Existing	67324.00	392.00	414.49		414.80	0.000170	4.57	16446.44	1097.14	0.18
Reach	327.0046	Q100	Alt C	67324.00	392.00	414.49		414.80	0.000170	4.57	16446.44	1097.14	0.18
Reach	327.0046	Q500	Existing	80942.00	392.00	416.42		416.78	0.000175	4.94	18568.01	1102.42	0.19
Reach	327.0046	Q500	Alt C	80942.00	392.00	416.42		416.78	0.000175	4.94	18568.01	1102.42	0.19
Reach	327.0046	1987 (Q200)	Existing	69885.00	392.00	414.87		415.19	0.000171	4.64	16861.31	1098.18	0.19
Reach	327.0046	1987 (Q200)	Alt C	69885.00	392.00	414.87		415.19	0.000171	4.64	16861.31	1098.18	0.19
Reach	327.0046	1936 (Q500)	Existing	80745.00	392.00	416.40		416.76	0.000175	4.93	18546.11	1102.37	0.19
Reach	327.0046	1936 (Q500)	Alt C	80745.00	392.00	416.40		416.76	0.000175	4.93	18546.11	1102.37	0.19
Reach	327.0046	Q1.1	Existing	18963.00	392.00	403.83		403.96	0.000175	2.91	6517.79	687.99	0.17
Reach	327.0046	Q1.1	Alt C	18963.00	392.00	403.83		403.96	0.000175	2.91	6517.79	687.99	0.17
Reach	4.7555	Q10	Existing	47180.00	392.00	411.12	398.69	411.31	0.000148	3.50	13794.61	1135.20	0.16
Reach	4.7555	Q10	Alt C	47180.00	392.00	411.12	398.69	411.31	0.000148	3.50	13794.61	1135.20	0.16
Reach	4.7555	Q25	Existing	55409.00	392.00	412.63	399.38	412.84	0.000148	3.69	15700.84	1350.31	0.17
Reach	4.7555	Q25	Alt C	55409.00	392.00	412.63	399.35	412.84	0.000148	3.69	15700.84	1350.31	0.17
Reach	4.7555	Q50	Existing	61408.00	392.00	413.59	399.81	413.82	0.000148	3.83	17000.67	1357.69	0.17
Reach	4.7555	Q50	Alt C	61408.00	392.00	413.59	399.81	413.82	0.000148	3.83	17000.67	1357.69	0.17
Reach	4.7555	Q100	Existing	67324.00	392.00	414.49	400.24	414.73	0.000148	3.96	18225.69	1364.60	0.17
Reach	4.7555	Q100	Alt C	67324.00	392.00	414.49	400.24	414.73	0.000148	3.96	18225.69	1364.60	0.17
Reach	4.7555	Q500	Existing	80942.00	392.00	416.43	401.16	416.70	0.000148	4.23	20837.47	1379.50	0.17
Reach	4.7555	Q500	Alt C	80942.00	392.00	416.43	401.17	416.70	0.000148	4.23	20837.47	1379.50	0.17
Reach	4.7555	1987 (Q200)	Existing	69885.00	392.00	414.87	400.42	415.12	0.000148	4.02	18744.80	1367.52	0.17
Reach	4.7555	1987 (Q200)	Alt C	69885.00	392.00	414.87	400.40	415.12	0.000148	4.02	18744.80	1367.52	0.17
Reach	4.7555	1936 (Q500)	Existing	80745.00	392.00	416.41	401.15	416.68	0.000148	4.23	20859.89	1379.35	0.17
Reach	4.7555	1936 (Q500)	Alt C	80745.00	392.00	416.41	401.13	416.68	0.000148	4.23	20859.89	1379.35	0.17
Reach	4.7555	Q1.1	Existing	18963.00	392.00	403.79	396.12	403.90	0.000148	2.65	7144.80	761.49	0.15
Reach	4.7555	Q1.1	Alt C	18963.00	392.00	403.79	396.12	403.90	0.000148	2.65	7144.80	761.49	0.15



Contraction Scour

	Left	Channel	Right
Input Data			
Average Depth (ft):	20.26	1.95	
Approach Velocity (ft/s):	5.69	0.69	
Br Average Depth (ft):	20.04	2.30	
BR Opening Flow (cfs):	67019.26	304.74	
BR Top WD (ft):	588.28	183.03	
Grain Size D50 (mm):	2	2	
Approach Flow (cfs):	66942.04	381.97	
Approach Top WD (ft):	580.44	283.78	
K1 Coefficient:	0.690	0.690	
Results			
Scour Depth Ys (ft):	0.05	0.00	
Critical Velocity (ft/s):	3.46		
Equation:	Live	Live	

Pier Scour

All piers have the same scour depth

Input Data	Pier Shape:	Square nose
	Pier Width (ft):	6.50
	Grain Size D50 (mm):	2.00000
	Depth Upstream (ft):	20.12
	Velocity Upstream (ft/s):	5.45
	K1 Nose Shape:	1.10
	Pier Angle:	0.00
	Pier Length (ft):	40.25
	K2 Angle Coef:	1.00
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (mm):	20.00000
	K4 Armouring Coef:	1.00
Results	Scour Depth Ys (ft):	12.04
	Froude #:	0.21
	Equation:	CSU equation

Abutment Scour

	Left	Right
Input Data		
Station at Toe (ft):	195.15	889.11
Toe Sta at appr (ft):	614.85	1242.73
Abutment Length (ft):	55.75	283.78
Depth at Toe (ft):	-3.76	2.54
K1 Shape Coef:	1.00 - Vertical abutment	
Degree of Skew (degrees):	90.00	90.00
K2 Skew Coef:	1.00	1.00
Projected Length L' (ft):	55.75	283.78
Avg Depth Obstructed Ya (ft):	20.26	1.95
Flow Obstructed Qe (cfs):	6429.98	381.97
Area Obstructed Ae (sq ft):	1129.69	552.13
Results		
Scour Depth Ys (ft):	8.19	
Froude #:	0.09	
Equation:	Default	HIRE

Combined Scour Depths

Pier Scour + Contraction Scour (ft):	Channel:	12.09
Right abutment scour + contraction scour (ft):		8.19